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EDITORIAL

A NOTABLE CONVENTION

The Dayton convention of the American Society of Municipal Improvements surpassed any previous convention in total registration, in enrollment of members, and in proportion of members in attendance, more than forty per cent. of the total membership of the society being present. The interest was unflagging, as shown by the length of sessions and evident willingness of members to continue the discussions indefinitely, as well as by the continued large attendance at the sessions.

As usual, the major part of the program was occupied with papers upon paving. The discussion of wood block paving was particularly extended, and, while specifications for this class of paving were not finally adopted, the committees agreed to consider as the most important subjects the manner of treating blocks and laying pavements and to lay less stress upon the particular materials with which the blocks should be treated, thus following the suggestion made by this magazine some four years or more ago and repeated elsewhere at intervals ever since.

After much discussion and difference of opinion and several reversals of action in the committee meetings, a report on bituminous macadam paving was finally brought before the convention, which followed the instructions given the committee by the Boston convention last year, and it was adopted by a substantial majority. There was some criticism of this action, since it adopted a specification for a patented pavement, but it was generally considered to be a straightforward acknowledgment of a situation which has heretofore been temporized with by organizations engaged in standardizing specifications. The subject has been directly before the Society for several years and it has never been willing to accept the specifications adopted by the A. S. P. S., and two conventions have now passed upon the matter after long continued discussions in committees and on the floor of the convention.

The governmental departures of Dayton were explained fully, and many members seized the opportunity to make close studies of methods and results, in which they were greatly aided by the Municipal and County Exhibit, which was in progress for the benefit primarily of Dayton's citizens.

Interesting papers and discussions on garbage disposal, sewage disposal, water supply, city government problems added to the general satisfaction with the convention.

LIABILITY FOR FAILURE OF WATER SUPPLY

A recent decision of the North Carolina Supreme Court that the Washington Light and Water Co., was liable for damages from lack of water pressure during a fire brings out a discussion by a dissenting justice showing that the overwhelming majority of decisions have been against such liability unless it is definitely assumed either in the franchise accepted by the company or in the contract with the city, or with the private consumer for water and pressure for fire purposes. Decisions asserting liability beyond loss of hydrant rentals or water rates due to failure of supply are few in number and almost without exception are based upon definite provisions in the contracts with city or with consumer.

If the delinquent water works plant is owned by the city, its failure to supply sufficient water or pressure does not make the city liable for a resulting fire loss, decisions ordinarily falling back on the principle that the municipal officials are exercising their best judgment and neither the city nor they, in the absence of fraud, can be held liable for mistakes in judgment. Since the city delegates its power to supply water for such purposes to a company, where ownership of the water works is private, it would seem but proper that, within the same limitations, the company should be required by the courts to assume no further liability than the city itself would have had. Doubtless this principle is recognized, tacitly at least, in many decisions tho it may not appear in the formal decisions. If the city should see fit, however, to include in franchise or contract with a water company the provisions that the company should be liable for damage due to failure of supply or pressure at any time, it would not be stepping beyond its rights and powers and by taking such action, if accepted by the company, would create such liability. Otherwise there seems to be no sufficient reason why the company should be held any more liable for such damage than the city itself would be if it owned and operated the plant.

RECONSTRUCTION OF HAMILTON, ONTARIO, WATER WORKS

By Andrew F. Macallum, City Engineer.

The author of this paper before the American Society of Municipal Improvements is the president of that organization and the city engineer of Hamilton, Ontario, whose new water supply system he describes. Some interesting methods of overcoming the difficulties met are given, together with some valuable figures of cost. The fluctuation in cost of laying pipe from day to day is shown in one table and diagram and puts in definite form the general ideas which many engineers have had on this subject.

THE city of Hamilton, Ontario, completed its first waterworks system in 1859, which system was developed ally to meet the growth of the city until 1912, when it was found that the rapid growth of the city necessitated the complete renewal of the entire system. At this time there were in operation four steam pumps, having a combined discharge of thirteen and one-half million gallons (imperial) per 24 hours and three mains to the city 18-in., 20-in. and 30-in. respectively. Two of these pumps and the 18-in. main were installed and in continuous use since 1859 and these pumps of the vertical walking beam plunger type are today somewhat of a curiosity. These old pumps are yet in commission, but used only in the event of interruption to the electrically driven turbine pumps installed during the reconstruction and when the other two and newer steam pumps cannot meet the demand.

Hamilton, Ontario, lies at the westerly end of Lake Ontario, where at its extreme end a sand ridge cuts off the lake from the Burlington Bay, on the shores of which the city lies. Owing to its location and this sand ridge, thru which a short canal is cut to the lake, combined with the fact that most of the sewage from the city is treated at disposal works before entering the bay, it has never been found necessary to treat the water taken by the intakes from Lake Ontario. This places this city in the unique position of being about the only city drawing water from the Lower Great Lakes that has not to treat its water supply. In connection with the original installation two intakes extended into the lake, one cast iron, 20 inches in diameter, for a distance of 1,000 feet and a wooden box intake three feet square a distance of 300 feet, each having its inner end in a settling basin from which wooden conduits lead to the wells at the pumping station. It is interesting to note that one of these wooden conduits placed in 1859 was found to be in first-class condition after 55 years' service.

It was decided to construct a new intake, 4 feet in diameter and 2,100 feet in length, which would bring it to a depth of thirty-two feet of water in the lake. This steel intake pipe, including intake piece, sluice valve and expansion joints, cost $20,520 delivered on the site and riveted in lengths approximately 140 feet, on the ends of which were flanged pieces. The price mentioned includes also the lead gaskets and bolts.

The accepted tender for laying this pipe was $35,000, which included the building and placing of the intake crib and a concrete valve chamber and house at the settling basin end. As ice ridges formed out in the lake for a distance of about 1,000 feet and in some places thirty feet high, to protect the pipe it was necessary to lay the pipe in trench on the lake bottom so that when filled in again the pipe was covered. Concrete in bags was placed around the pipe for 300 feet from the shore as an added precaution. Four piles were driven in the trench in such a position that when a 140-ft. section was floated into position two piles would be at each end of the section. Across the two piles at each end a sill was bolted at grade and the pipe was lowered to rest upon these sills and held in position there by wooden blocks on either side. A cap was bolted across the two piles over the pipe after the section had been bolted to the preceding section by the divers. Besides alignment the object in driving these piles was two-fold: first, for ease in joining up two sections clear of the sand, and secondly, to prevent as much as possible divers not bolting up the lower sections of the pipes because of difficulty of access. As there was practically little possibility of scour on account of the method of construction adopted, it was not considered necessary to space the piles closer, and I may say that the above arrangement has proved quite satisfactory.

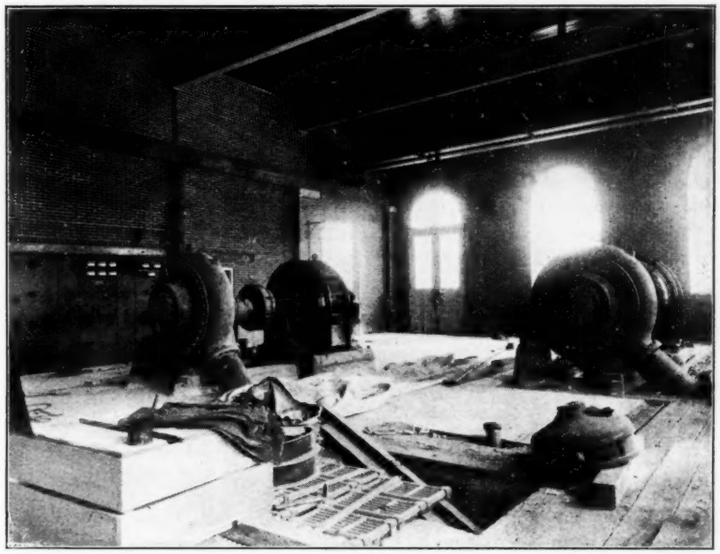
In an examination of the plans for intake cribs adopted by the cities on the Great Lakes it was found that the minimum size was forty feet square and of sufficient height that the mouth of the intake facing upwards was at least seven feet above

THE INTAKE PIPE *of the Hamilton water works riveted up in lengths of* 140 *feet on the lake shore, ready for laying. Diameter,* 48 *inches.*

the bed of the lake. This minimum size I did not consider necessary, but designed the intake crib to be 24 feet square, placing rip-rap around the outside, and this has since been found quite sufficient. No iron was exposed about the intake openings, but these were constructed with oak plank to prevent the formation of anchor ice. In the gate-valve house were placed fish screens for obvious reasons. A reinforced concrete conduit 4 feet in diameter and 2,000 feet long was constructed to the large well at the pumping station. This conduit before reaching the pump well passed thru a screen chamber thru which the old two wooden conduits also passed. At the intake and outlet of each conduit was placed a sluice valve so that any conduit could be cut off or either part of a conduit. Each of the turbine pumps feeds from a small and separate well connected with the main well with a gate-valve cut-off. By this method any foot valve could be inspected and repaired if necessary without interfering with the water supply of the other pumps.

On account of the low cost of electric power ($16.50) per annum, it was decided to increase the number of electric driven pumps to meet the future demands and the pumping station for the units already installed was enlarged. Two new electric-driven turbine pumps were installed, each of six and a half million gallons (Imperial) per 24 hours, or of the same capacity as two units already in operation. There is a steam plant also having a capacity of 13,500,000 gallons per 24 hours which is generally held in reserve to carry the peak load during periods of heavy consumption.

The subject of plunger pumps has been well covered in several text books, but the development of the centrifugal into its present efficiency is less known. This applies not only to the design and construction, but also to its operation, and it is only comparatively recently that it has been efficiently applied to pumping problems. Almost any machine shop or foundry could build a centrifugal pump that would deliver more or less water against a certain head, but little attention was given to efficiency, accessibility or operation, everything being sacrificed to low first cost. Most pumping station centrifugal pumps are driven by electric motors and consequently the operating cost is a definite and known quantity and it then becomes a question of getting the maximum efficiency from the pump under the existing conditions.



MAIN PUMPING STATION *or beach station during construction, showing the two electrically driven turbine pumping units.*

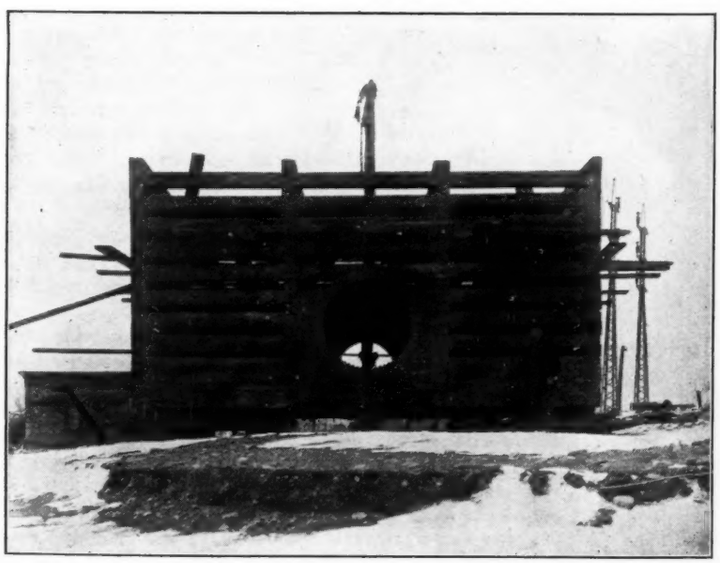
A centrifugal or turbine pump has certain fixed characteristics. For instance, in a turbine pump operating at constant speed, as it will if driven by synchronous motors, the amount of water pumped increases with the drop of pressure in contra-distinction from the piston pump, which always pumps the same quantity of water no matter what the pressure.

If then a turbine pump is designed to deliver a quantity of water through a pipe or a piping system of certain diameters and length at its maximum efficiency and another turbine of exactly the same characteristics is started to pump thru the same piping system the frictional head from the delivery piping will increase due to the increased quantity of water and consequent increased velocity of water thru it with the result that the increased head will reduce the individual deliveries, so that the total delivery from the pumps is equal to twice the delivery of the individual pump at the increased head, instead of twice that of the original pump if pumping by itself. If these two pumps are to work together most of the time the efficiency curve for each pump should be at its maximum over the variations in head between one and two pumps working.

If two turbine pumps deliver into piping system that decreases the individual delivery of each pump by more than 10 per cent. It will have the tendency to cause the delivery to swing from one pump to the other so that one pump will be delivering water and the other practically churning. This may be remedied by increasing the sizes of the impellers.

It is usual to keep the suction tubes of all pumps under twenty-five feet and most pumps

THE INTAKE CRIB *ready to launch, tow to location and sink to place on the bottom of the lake.*



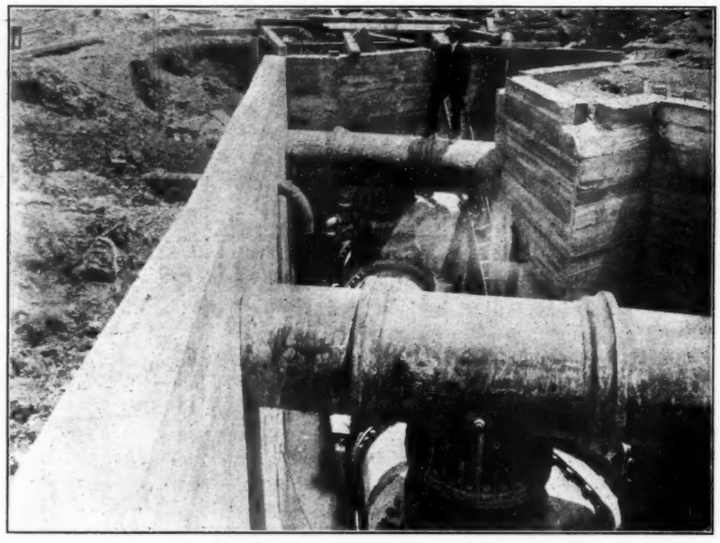
have their suctions at not greater than twenty feet to minimize the possibility of air leakage.

It has been found in a number of cases with turbine pumps that the tips of the impellers wear very rapidly when the suction tube is greater than twelve feet. Less than this height there is little or no wear and the reason for this is probably due to imperfections in design of the turbine pump as built today, although some manufacturers guarantee over 80 per cent. efficiency.

The two-stage turbine pumps that the city of Hamilton installed at its main pumping station pump to a head of 285 feet with an efficiency of 75 per cent. under full load. The tenders for two 6,500,000-gallon (Imperial) turbine pumps in place varied from $5,500 to $9,800. Extra impellers capable of lifting the water to 300 feet were included and the pumps had to be successfully operated for two weeks before acceptance.

Besides the main pumping station there was built a booster station to replace steam and air-lift pumps and to carry the water to greater elevations than possible with the main pumping station without causing excessive pressures in the lower portion of the city. This station contains four turbine pumps each of one million imperial gallons per 24 hours. Two of these pumps raised the water about 80 feet above the level of the reservoir to which the main station pumps delivered the water and two pumps raised the water 280 feet above this level. Two-stage pumps only were necessary for the lower level below the mountain plateau, but six-stage pumps were required for the higher elevation. The problem at this station was to approximately determine the head to which the pumps would generally work so as to get the greatest efficiency out of them. The pumps were directly connected to the mains fed from the main pumping station and about 75 feet below the level of the reservoir that the main station fed.

Besides the usual annual and daily fluctuations in head with the added effect of the draft of these pumps on the static head there was the difference in level of two reservoirs on the main system to be considered. One of these reservoirs



THE HEADER *at the beach pumping station, 48 inches in diameter, with two connected 30-inch supply mains and the controlling valves.*

was only used in case of emergency or while cleaning or repairing the reservoir generally used, but as it was 60 feet lower in elevation and two miles distant across the city and nearer the pumping station, it naturally produced considerable variation and practically made the problem of obtaining maximum efficiency with turbine pumps under all working conditions indeterminate. The pumps as built and operated give a maximum efficiency of 60 per cent. altho under certain conditions the specified efficiency of 75 per cent. is obtained.

Tenders for these four pumps in place varied from $6,000 to $6,800.

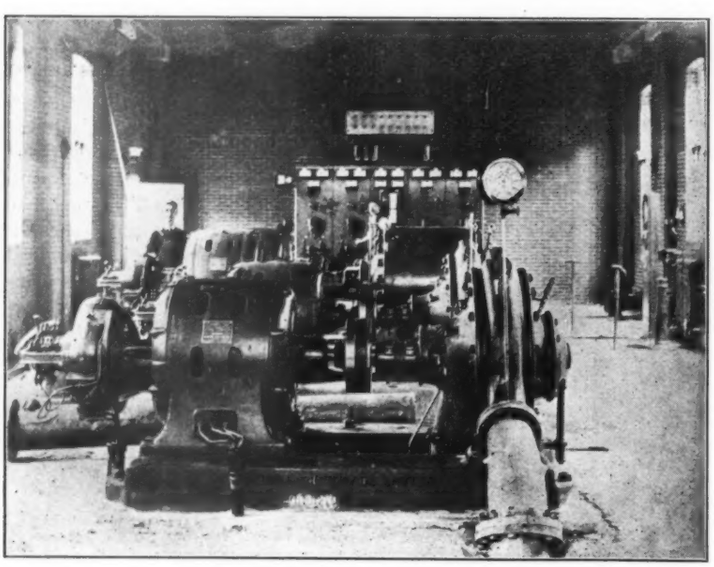
The main pumps are driven by 750-h.p. motors, the lower level pumps at the booster by 50-h.p. motors and the higher level by 130-h.p. motors. All these pumps run at 750 r.p.m.

As stated before, there were in commission from the main pumping station, three rising mains, 30, 20 and 18 inches respectively, being connected to the pumps in the usual haphazard way prevalent thruout many plants in this country. It was decided to build a fourth main 36 inches in diameter and about equal to the other three mains in discharging capacity. Altho nearly two miles of this main had to be built to bring it to the outskirts of the city along a pipe line already used by the other three mains, it was decided to take a slightly longer route away from this pipe line to avoid the danger of a bad blow-out putting all the mains out of commission.

The connections from the pumps were carried to a header pipe 4 feet in diameter running at right angles and at a lower elevation than these connecting pipes.

Between each of the old pipes and the header a gate valve was placed, and as the new 36-inch main went off from the end of the header the whole arrangement proved very flexible in operation. On each of the mains was the usual check and gate valve, besides the venturi tube for measuring the discharge. Before laying the large main to the city and other mains thruout the city, tests were made to ascertain the relative efficiency and speed

HIGH LEVEL PUMPING STATION, *showing four pumping units raising water to two levels.*



in making poured and lead wool joints, also the relative efficiency of joints calked by pneumatic hammers or by the usual hand method.

It was found that with the pneumatic hammers between four and five joints could be calked with a poured lead joint to one by using lead wool. This was due generally to the hammers becoming wedged in driving. It was also found that the compression in the calking went deeper in the poured than in the wool joint with the consequent greater density.

Several alternate joints were calked by the pneumatic hammers and by hand and this section was gradually put under pressure. It was found that every joint calked by hand commenced to leak slightly at 110 pounds pressure, but that the pneumatic calked joints remained tight.

To carry the construction of these mains thru quickly and efficiently by the city forces an air compressor with pneumatic calking tools was purchased.

The city had a small steam shovel with a half-yard dipper which did the excavating and also the lifting of the pipe into the trench. A 12-ton dinky engine with cars and track was also purchased and with this equipment (which also did the back filling) as high as fifteen 36-inch pipe were laid in a day in a trench which had a variable depth, but always sufficient to give a top covering over the pipe of five and a half feet. This large main was laid to grade with blowoffs every half mile to the city and having the usual gate and relief valves.

To compare the relative speed of hand and pneumatic calking tests were made with the results shown in the following table:

Size.	Class.	Depth of Lead Joint.	Weight of Lead Used.	Depth of Yarn.	No. of Hand Calkers.	No. of Joints per Day.	No. of Machine Calkers.	No. of Joints per Day.
36 in.	C.	3½ in.	121	1 in.	2	4	2	12
30 in.	C.	3 in.	90	1 in.	2	6	2	15

From which it will be seen that in the 36-inch pipe the machine men calked three times as many joints as the hand men and two and a half times as many in the 30-inch pipe. Thru many local conditions entering, as for instance the filling in of old wooden bridges and building of concrete culverts which were charged to the cost of the mains to the city, no cost data are given, but a length of 2,157 feet of 24-inch mains in the city under normal conditions is given for depth from seven to nine feet with conditions causing the variation in cost of laying indicated. The average cost per foot was $1.86 for this size of pipe.

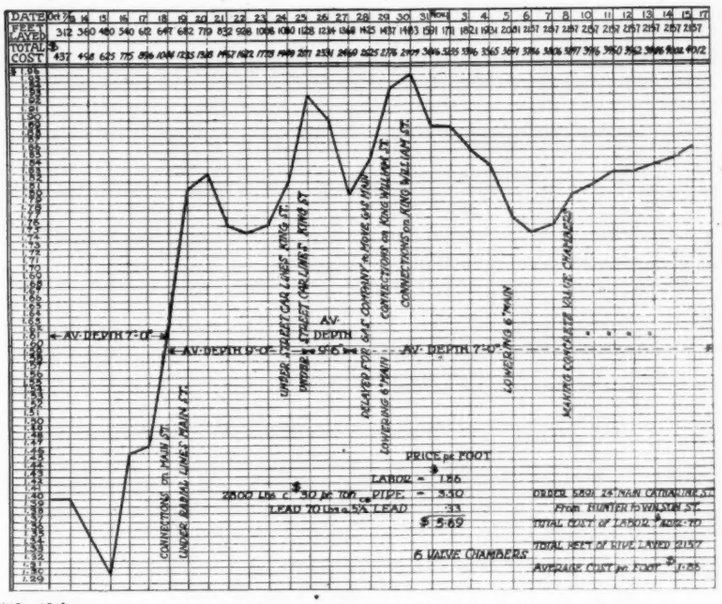
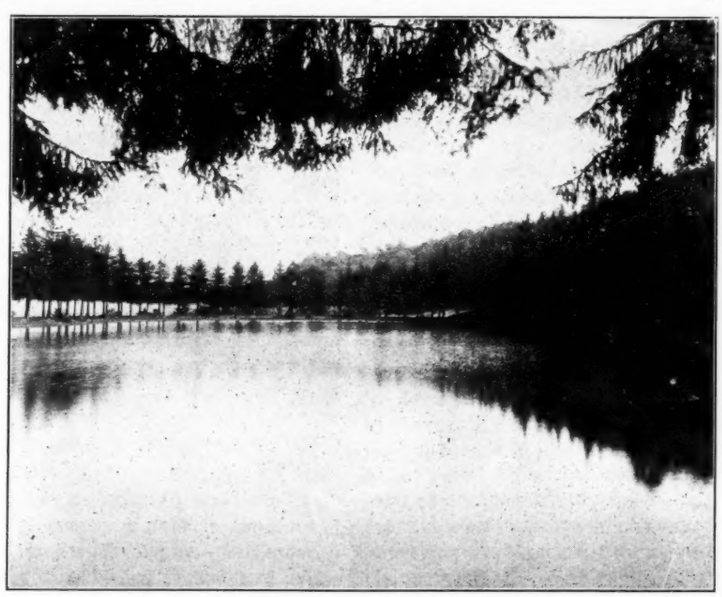

DATE
FEET LAYED
TOTAL $ COST
AV. DEPTH 7'-0"
AV. DEPTH 9'-0"
AV. DEPTH 7'-0"
CONNECTIONS on MAIN ST. UNDER RADIAL LINES MAIN ST.
UNDER STREET CAR LINES KING ST.
UNDER R.R. KING ST.
LOWERING 6" MAIN
CONNECTIONS on KING WILLIAM ST.
LOWERING 6" MAIN
LOWERING 6" MAIN
MAKING CONCRETE VALVE CHAMBERS
PRICE per FOOT
LABOR = 1.86
PIPE = 3.30
LEAD 70 lbs. @ 5¢ = 3.50
LEAD = .33
$ 5.69
6 VALVE CHAMBERS
ORDER 52ND 24" MAIN CATHARINE ST.
From HUNTER to WILSON ST.
TOTAL COST of LABOR, PIPE & LEAD
TOTAL FEET OF PIPE LAYED 2157
AVERAGE COST per FOOT = 1.86

DIAGRAM *showing the fluctuation in the cost of laying pipe from day to day and the conditions governing.*

The length in feet of new mains in this reconstruction comprised:

36 inch	12,900
30 inch	13,800
24 inch	6,000
20 inch	4,600
18 inch	2,500

and the total cost of this work including intake, conduit, pumping stations and mains was $750,000.



BARTON LOW-LEVEL RESERVOIR, HAMILTON WATER WORKS.

Types of Bituminous Construction

By Francis P. Smith, Ph. B., Mem. Am. Soc. C. E., M. A. I. C. E., New York City.

The development of the use of bituminous materials in road and street surfaces has covered all methods of using bitumen in such construction from the simple oiling of an earth road to the most scientifically designed and constructed asphalt or bitulithic pavement. As a consequence there have been numerous questions as to the proper classification of pavements and road surfaces, most of these having arisen in connection with the formulation of standard specifications for various classes of bituminous road and street construction. The distribution of subjects to committees for study and experiment has also led to some similar questions.

This paper before the American Society of Municipal Improvements is by one of the most active workers in the field of experimentation and examination of methods and results, as well as in the formulation of specifications, and he is well fitted to make the classification of methods of bituminous construction, which is the real result of his discussion. It should aid in reaching agreement upon a definite classification.

THE selection of the most economical and suitable types of bituminous road construction to meet a given set of traffic, climatic, subsoil and drainage conditions, involves a clear comprehension of the limitations of the various types in use and the conditions essential to their successful employment. Certain conditions should absolutely preclude the use of certain kinds of construction regardless of possible low first cost and disregard or lack of knowledge of the vital principles underlying different forms of construction has often resulted in the waste of large sums of public and private money.

Whatever type of construction is decided upon, it must always be borne in mind that a bituminous wearing surface is flexible and will only give good service when it is properly supported by an adequate foundation. Soft spots or weak places in the foundation will cause a settlement of the overlying wearing surface, which will result in rapid deterioration. Water will collect in such low spots and rapidly destroy the bond between the bituminous binder and the mineral aggregate. The wheels of each vehicle passing over such depressions will strike a heavy blow as they drop down into them and cause displacement of the wearing surface, resulting in the formation of a ridge which still further adds to the vibration of the springs and causes successive blows to be dealt to the pavement until the spring vibration becomes normal again. This, of course, results in the formation of waves. In most heavy commercial vehicles the springs are comparatively short and stiff. The vibrations are, therefore, quick and tend to strike very heavy blows, resulting in wave formation at right angles to the line of traffic, having their crests from 3 to 4 feet apart. This is plainly noticeable on roads having a bituminous wearing surface and it is still more evident on water-bound macadam roads. The poorer and less rigid the formation the more pronounced the waves. This is quite distinct from the shearing or shoving action exerted by vehicles rounding curves at a moderately high rate of speed. The motor bus is perhaps more directly responsible for this type of wave formation than any other modern type of vehicle. In England, more especially in the neighborhood of London and other large cities, it is easy to pick out those roads which carry motor-bus traffic, as they invariably show the kind of wave formation above described. On water-bound macadam roads it is no uncommon thing to find considerable stretches in which the difference in level between the wave crests and troughs amounts to 4 inches and over. This wave formation is noticeable in rock and sheet asphalt pavements laid on 9 inches of concrete, as well as on country roads covered with sheet asphalt, tarred slag, bituminous concrete or bituminous macadam. Generally speaking, the wave formation in sheet or rock asphalt pavements laid on concrete foundations, while noticeable, is not excessive, whereas in bituminous surfaces on inferior macadam foundations it is one of the primary causes of disintegration. The consistency of the bituminous binder used in these English roads is on the average somewhat harder than that used in the United States and there are no long hot periods to soften them up such as are frequent here. In their very moist climate it has been found that a harder bitumen adheres more tenaciously to the mineral aggregate and is less affected by water action. It is fair to assume, therefore, that their road surfaces are at least no more plastic than ours and personal examination showed that in the majority of them the bonding qualities of the bitumen had not been weakened by water action and that the grading of the mineral aggregate was normal. The writer believes that much of this could be avoided by having longer and more flexible springs on vehicles of this type, thus greatly lessening the road shock.

Slow moving, heavily loaded vehicles are much more prone to cause displacement and wave formation than are the lighter type of vehicles moving at a speed of from 15 to 25 miles per hour. This was clearly shown by a 60-foot street in one of our eastern cities which was paved with a bituminous concrete mixture containing more stone than the average Topeka mixture. The foundation was 5 inches of concrete and the average grade about 3 per cent. A trolley line in the center of the street sharply divided the moving traffic. The traffic uphill was composed largely of slow moving, loaded, 3 to 4-ton horse-drawn vehicles and a few motor trucks, whereas on the down grade it was confined to light delivery wagons and empty trucks, but the number of vehicles on each side was about equal. The pavement on the uphill side very soon developed wave formation to such an extent as to require a large amount of resurfacing, whereas, that on the down-hill side gave satisfactory service for a long period, with practically no wave formation. Both sides were laid with the same mixture and at the same time. The concrete in many places was defective and at these points the wave formation was most marked.

In the writer's opinion, wherever the traffic calls for a bituminous surface, a concrete foundation is justified and is economically sound. There is always movement in a macadam foundation, as evidenced by the rounded edges of the

stone of which it is composed. This is noticeable wherever a macadam road is dug up or scarified. If the larger particles of stone are screened out from the mass and examined, their edges will be found to have become rounded by attrition. Where the traffic is very light, as on country roads which are not main arteries from or between large cities, and in some residential streets, old macadam roads have proved to be suitable foundations for bituminous surface mixtures. Far more failures than successes have resulted from their use, however, and great caution should be observed with respect to employing them. Many roads are classified as macadam roads, which contain no base course of large stone and are in reality old dirt roads on which comparatively fine stone has been dumped and consolidated by traffic, no provision having been made for their proper drainage. Unless constructed on a sandy soil, such roads inevitably become quagmires in spring when the frost comes out of the ground and are totally unfit for use as a foundation. New York state has many miles of penetration roads constructed on such foundations which have utterly failed, sometimes within six months after they were laid. Before using any macadam road as a foundation, its history should be investigated and more particularly its behavior in the spring of the year. The character and depth of the stone should be determined by putting down a sufficient number of test holes and proper under and side-drainage must be provided. In most instances it will be found necessary to rebuild the road in many places. Assuming it to have been a properly constructed and drained macadam road, and hence suitable for a light traffic foundation (and the number of these is very few), it will be necessary to regrade it and probably to reduce its crown before placing any bituminous surface upon it. In a few cases this can be done by filling up the depressions and building up the shoulders. Wherever possible, this method should be employed, as traffic will compact a road far better than is possible with a roller, and a road surface which has been scarified and then rolled will never be as hard and firm as if it had been compacted by years of traffic. Where new stone is added in depressions or on the shoulders, the road bed on which it is laid should be clean and slightly loosened to insure proper binding of the new stone. The size of the added stone should be the same as that which would be employed in building up the corresponding portions of a new water-bound macadam road and should be thoroly rolled with a road roller weighing not less than 10 tons until it is well compacted and vehicles passing over it do not cause displacement. Water and screenings should be used during rolling to effect this. Unless this work is thoroly and conscientiously done, the foundation will not be of uniform strength thruout and settlements will probably occur at those places where the new stone has been put in.

If it is necessary to scarify the road surface, this should be done with care not to go deeper than necessary and the surface of the road should be built up with new material and rolled until the greatest possible compaction is obtained, exactly as if building a new water-bound macadam road. If it is then possible to turn traffic upon it for a few months before laying the bituminous surface, so much the better, as any weak spots will be developed and still greater compaction will be secured. To do all this thoroly and as it ought to be done (including drainage) will often cost almost as much as putting down 5 inches of concrete. With the concrete a permanent and satisfactory foundation is assured, which may be re-surfaced when necessary at the minimum expense. In England, a number of fairly heavy traffic roads have been successfully surfaced with sheet asphalt or bituminous concrete, using the old macadam as a foundation, but as a rule their macadam roads have been in existence for a long time and have been properly constructed and, owing to their moist climate, have been thoroly drained. They, therefore, start with a much better foundation, on the average, than we can hope to obtain. Their winters are mild and frost rarely penetrates to any considerable depth into the earth, hence they are free from heaving and the unstable conditions produced by our spring thaws.

Where the sub-soil drainage and climatic conditions are especially favorable, a foundation of 4 to 6 inches of broken stone, properly consolidated by rolling, may be used for light traffic roads. Except under extremely favorable conditions, the proper construction and drainage of a base of this kind will cost more than would 4 to 5 inches of concrete.

The question of foundation having been settled, the kind of wearing surface must next be determined. The various types of bituminous construction under consideration may be classified as follows:

Coarse Aggregates—Penetration method, cold mixture, hot mixture.

Fine Aggregates—Topeka, sheet asphalt.

As between coarse and fine aggregates, the heavier the traffic (more especially that carried on iron tires), the finer should the mineral aggregate be. Large particles of stone will be fractured sooner or later by the passage of heavy loads over them. Wherever such a fracture occurs, we have two faces which are not cemented together by bituminous cement. This permits grinding away and the entrance of water, two extremely destructive agencies. As illustrative of this, in certain sheet asphalt pavements laid by the writer in heavily traveled sections of Glasgow, Scotland, it was found to be necessary to exclude grains of sand coarser than those passing a 20-mesh screen, as even 10-mesh grains would crack and permit the water to enter and destroy the pavement. In a test made this winter in the presence of the writer of a bituminous road surface at the National Physical Laboratory at Teddington, England, in which a road continually flooded with water was tested to destruction by the passage of heavily loaded iron-tired wheels over it, it was found that disintegration commenced at those points where large sized grains occurred on the surface. Large sized aggregates give a rougher road surface, and hence better foothold for horses than do smaller sized aggregates, and automobiles are less liable to skid upon them in wet weather. For light and moderate traffic there is, therefore, much to be said in favor of large sized aggregates. As between penetration methods and mixing methods, the latter are undoubtedly far superior. In the case of portland cement concrete, except in special forms of construction, grouting is seldom resorted to except where mixing is impossible and in this case we have a fluid cement which readily penetrates the interstices without chilling or becoming solid for a very considerable period of time. When grouting broken stone with a hot bituminous cement, its tendency is to chill as soon as it strikes the colder stone. Its distribution is, therefore, very uneven and whenever the interstices are small practically no penetration takes place. Work of this character should never be done except in the hottest weather and yet we see many of these roads constructed in the late fall. It is really the most difficult kind of bituminous work to execute properly and yet, because of the cheapness of the plant required, many contracts are let to small contractors who have never done such work before. A few years ago suitable portable mixing machinery was not available for work of this kind, except in the vicinity of railroads, and hence some type of bituminous construction had to be developed which was cheap and could be put down without the use of heavy and non-portable plants. These conditions no longer exist and the writer believes that for this and other reasons the penetration method of construction will gradually disappear. When, because of failure or increase in traffic, it becomes necessary to reconstruct a penetration road laid on a broken stone foundation, practically all of the road

must be removed, and this is an expensive piece of work. This is not true of a bituminous road laid on a concrete foundation. The foundation can still be utilized and in most cases resurfacing is all that is necessary.

As between hot and cold mixtures, the hot mixtures can be better graded and more thoroly compressed by rolling and are, therefore, somewhat better suited for fairly heavy traffic. For light traffic, the cold mixture will, in many instances, give equally good results and will often be very much cheaper, and will, therefore, always have a wide field of usefulness. Cold mixtures would appear to be ideal for use by road patrols in the upkeep of bituminous road surfaces constructed of large aggregates and are much superior to hasty mixtures of stone and bituminous binder, often imperfectly made on the spot with inadequate appliances by more or less inexperienced workmen.

The so-called Topeka mixture is intermediate between the sheet asphalt and the coarse aggregate mixtures. As ordinarily made, it consists of a standard sheet asphalt mixture, to which has been added from 15 to 25 per cent. of stone passing a ¼-inch screen and retained on a 10-mesh screen, and 10 per cent. or less of stone passing a ½-inch screen and retained on a ¼-inch screen.

Too little bitumen wil make a Topeka mixture open and water absorbent, and a variation of one-half of 1 per cent. of bitumen above or below its proper content is about the limit of safety. Double this variation in a sheet asphalt pavement will not seriously affect it. For medium and light traffic, the writer believes that a not too dense sheet asphalt mixture, laid the same thickness and under the same conditions as the Topeka, will give at least as satisfactory service and will be much safer to lay in the long run. The Topeka mixture appears to him to be a hybrid, possessing vices and weaknesses peculiarly its own and not as good as either of the types which it is intended in part to supplant.

For very heavily traveled city streets, sheet asphalt on concrete foundation is undoubtedly the best type of bituminous pavement. When sheet asphalt is laid on very light traffic streets, a somewhat coarser sand should be used than for heavy traffic streets. As the number of particles decreases, the surface area to be covered with bitumen also decreases. In this way, without increasing the percentage of bitumen in the mixture, a thicker coating of bitumen is obtained on each grain of sand and the pavement will not crack as readily under minimum traffic as will a standard heavy traffic mixture. All sheet asphalt pavements are improved and their life prolonged by the passage over them of sufficient traffic to exercise a constant kneading action and equalize the internal stresses set up by contraction and expansion.

A comparative table, showing the average composition of the various bituminous surface mixtures discussed herein, is given below:

	Coarse Aggregate		Fine Aggregate		
	Bituminous Concrete		Topeka	Sheet Asphalt	
	Hot Mixture Per ct.	Cold Mixture Per ct.	Per ct.	Light Traffic Per ct.	Heavy Traffic Per ct.
Bitumen	7.0	6.5	8.5	10.5	11.0
Passing 200 mesh....	5.0	4.5	8.5	10.5	14.0
Passing 100 mesh....	4.0	1.5	6.0	10.0	14.0
Passing 80 mesh....	2.0	1.5	6.0	10.0	13.0
Passing 50 mesh....	5.0	1.5	6.0	14.0	19.0
Passing 40 mesh....	4.0	1.5	10.0	14.0	11.0
Passing 30 mesh....	4.0	1.5	10.0	13.0	10.0
Passing 20 mesh....	3.0	3.0	9.0	10.0	5.0
Passing 10 mesh....	5.0	5.5	6.0	8.0	3.0
Passing 8 mesh....	3.0	5.0	6.0	...	...
Passing 4 mesh....	7.0	8.0	14.0	...	...
Passing 2 mesh....	20.0	40.0	10.0	...	...
Passing ¾-in mesh..	14.0	11.0	...	...	...
Passing 1 -in mesh..	12.0	9.0	...	...	...
Passing 1½-in mesh..	5.0	...	...	...	...
	100.0	100.0	100.0	100.0	100.0

Summarizing the foregoing brief discussion of the various principles and considerations involved in the different types of bituminous construction, we have the following:

FOUNDATION

Old Macadam—Suitable for light traffic under favorable climatic and drainage conditions, but only when properly constructed and drained. Thickness and character of stone layer and method of construction should be determined by test holes before adopting it. Road must be carefully shaped and graded, preferably by the building-up process, before laying any bituminous top upon it. Inferior to concrete.

Broken Stone—Suitable for light traffic, but only under favorable climatic and drainage conditions. Inferior to well-constructed old macadam and to concrete.

Concrete—Four to 6 inches thick, depending upon traffic and character of sub-soil. This is much the best type of foundation and is the least expensive to resurface.

COARSE AGGREGATE.

Penetration Method—Suitable for light traffic only; gives a rough surface; best results cannot be obtained except with skilled labor. Should only be carried on in hot weather and stone should be at a uniform temperature not below 60 degrees F. when binder is applied. No plant required, melting kettles being all that is necessary. Extreme care needed to prevent rich spots and bleeding. Stone must be carefully spread and fine material rigidly excluded from lower course, otherwise penetration of bituminous binder will not be satisfactory and uniform. Bituminous binder must not be overheated and must be at proper temperature and uniformly applied.

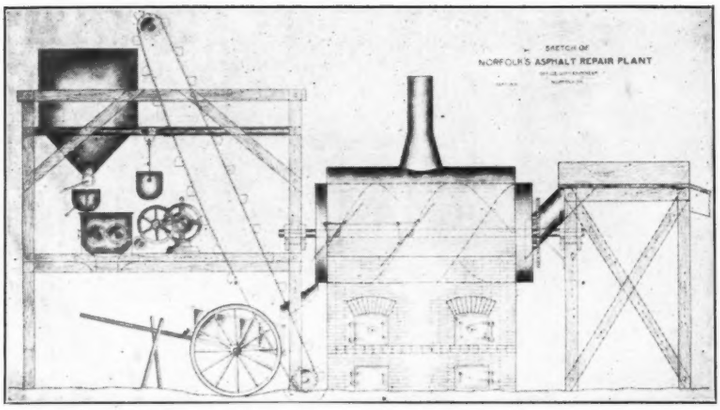
Cold Mixtures—Suitable for light traffic only; gives a rough surface. Stone must be clean and carefully graded. Bituminous cement must be of proper consistency, otherwise mixture will not be workable. Should not be laid at a lower temperature than 40 degrees F. Work should, preferably, be done in warm weather. Can be manufactured at the quarry from which the rock is obtained and shipped, ready to lay, to the work. Rolling should be continued until maximum possible compression is obtained. Especially suitable for repair work done by patrol gangs on coarse aggregate surface.

Hot Mixtures—Suitable for light and medium traffic only; gives a rough surface. Stone must be clean and carefully graded to secure best results. Can be laid at any time of year. Heating and mixing plants must be within hauling distance of the work. Rolling should be continued until maximum possible compression is obtained.

FINE AGGREGATES.

Topeka Mixture—Suitable for light and medium traffic; gives a comparatively smooth surface. Heating and mixing plant must be within hauling distance of the work. Great care must be exercised to keep bitumen contents within proper limits. Stone and sand should be weighed separately into mixer to secure uniform mixture. Can be laid at any time of year. Rolling should be continued until maximum compression possible is obtained. Unless very carefully manufactured, is more liable to shoving and displacement under traffic than is sheet asphalt.

Sheet Asphalt—Suitable for light, medium and heavy traffic, but should not be laid on as steep grades as are permissible with coarse aggregates. Gives a smooth surface and can be laid at any time of year. Heating and mixing plant must be within hauling distance of the work. Rolling should be continued until maximum compression possible is obtained.



ASPHALT REPAIRS IN SMALL MUNICIPALITIES

By W. H. Taylor, Jr., City Engineer, Norfolk, Va.

This paper before the American Society of Municipal Improvements gives one city engineer's experience in a field in which success has usually been doubtful. He seems to have secured good results with a home designed and constructed plant and tells where his troubles and mistakes have been, so that the information will be of interest to others, tho they may not have his success, even if they follow his methods exactly.

RECOGNIZING that each municipality has its own peculiar problem or unique situation to deal with, a general law for asphalt repair work can hardly be framed. The work and necessity of rectifying a few small patches, one extreme, differs materially from the restoration or reconstruction of an entire street surface, the other extreme. The former problem or question involving "Repairs and Repair Plant for Small Municipalities," the subject of this paper, is one upon which much time and money can yet be profitably spent.

Undecided after having investigated many plants manufactured for the purpose, I am still investigating the subject with a plant home made and with apologies intend giving an answer to the question at issue by briefly describing our efforts and the accompanying results.

The city of Norfolk, Va., has 80 miles of paved streets, 43.7 miles of which are of sheet asphalt or bitulithic construction, totaling 668,320 square yards. The streets of the city are on an average elevated 8 to 10 feet above mean sea level. Drainage and sub-soil conditions are unfavorable, occasioning unusual maintenance outlays.

As the scope of this paper will not permit of a discussion of our best and poorest efforts in constructing sheet asphalt, of contributory causes and errors revealed by time, leading to some early failures and numerous repairs, permit me to state that we have endeavored, when permitted, to follow closely expert advice and standard specifications, and have constructed streets that have endured reasonably heavy traffic for 15 years without repairs, and we have a few streets, repairs to which have aggregated to date over 50 per cent. of the original area. An analysis and subdivision of our streets into classes, according to various specifications, reveals the following relative durability and percentage of repairs. The age of the streets in the various classes being about the same and traffic conditions not dissimilar:

Class 1—Asphalt on concrete base—Streets without car tracks; yardage 189,200. Total repairs to date 2.6 per cent.

Class 2—Asphalt on concrete basis—Streets with car tracks; yardage 147,000. Total repairs to date 29 per cent.

Class 3—Asphalt laid on old cobble stone base—Streets without car tracks; yardage 14,236. Total repairs to date 39 per cent.

Class 4—Sheet asphalt laid without binder, on concrete base—Streets without car tracks; yardage 21,044. Total repairs to date 25 per cent.

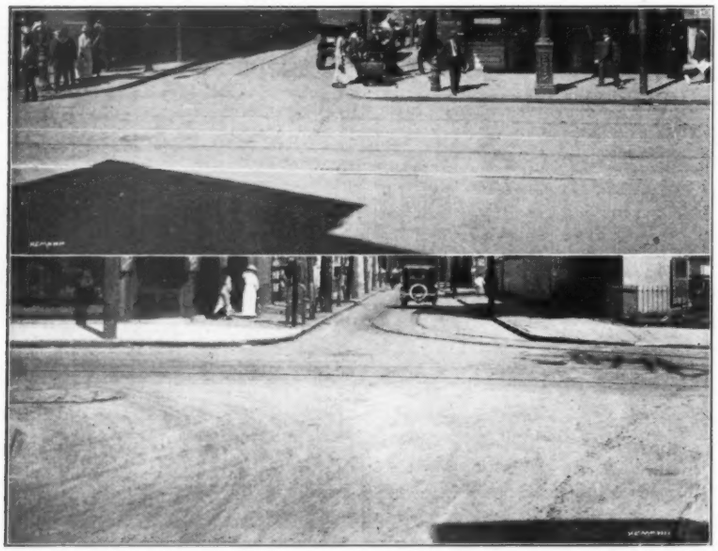
The question of repairs and of satisfactory equipment for making repairs became one of considerable moment and importance to the city of Norfolk within a very short time following the expiration of the guarantee period of the first large construction contract. Briefly stated, the methods pursued which have resulted in our present system, departing from the ordinary only in that we have used extensively for small repair work old surface mixture, vast quantities of which I have seen discarded and used for filling, have been as follows:

In 1908 the Barber Asphalt Paving Company having completed a contract in Norfolk involving both new work and extensive repairs, just before dismantling the plant, furnished the city 266 tons of sheet asphalt surface mixture. This was stored in layers separated by boards and cut in cubes before cooling. With painstaking care and unlimited patience the Department of Public Works of Norfolk made its first asphalt repairs by reheating the previously prepared mixture in a fire wagon built for the purpose. However, for very limited work only would I advocate or advise such a procedure.

With the above exception, from 1906 to 1912 repairs in Norfolk were made by contract, the price varying from $2.00 to $1.40 per sq. yd. exclusive of base. Our repairs at the present time average about 1,000 sq. yds. per month, to be exact, 23,500 sq. yds. the past 2 years, and are made by city pavers working usually one week each month, the material being manufactured by the city's own plant. This rate maintained annually amounts to 2¼ per cent. of the yardage of all pavements in the city five years old and over. Whether more or less in amount than it has been Norfolk's misfortune to cope with, everywhere repairs are inevitable, and in view of the extravagant and exacting demands of the traveling public, I repeat, preparations for repairs should in my opinion soon follow original construction.

Frequently in years past while waiting for a contractor's plant to become available we have had small holes spread from curb to curb, increasing in size with unbelievable rapidity, occasioning just complaints which we were powerless to correct.

Independence of the paving contractor for repairs, estab-



ABOVE. *Intersection Main and Bank streets, business district. Resurfaced with old material, August,* 1913.

BELOW. *Intersection Boush and Bute streets, semi-business district. Resurfaced with old material, July,* 1913.

lished by constructing a very small plant, has enabled us to keep Norfolk's streets in far more satisfactory condition and to reduce the cost of such work from the previous low price of $1.40 per sq. yd., average of $1.75 per sq. yd., to 60 cents per sq. yd. We have made many thousands of yards of repairs at 50 cents per sq. yd., using old material. The average cost above stated of 60 cents for the past two fiscal years, embracing the use of both old and new materials, includes all regular repair charges and 33 per cent. each year of the original total plant cost, itemized as follows:

Materials	$0.05
Labor at plant	.15
Labor on street, including haul	.30
Plant and tools	.06
Fuel and current	.02
Miscellaneous	.02
Total	$0.60

I submit herewith a free-hand sketch or diagram of the equipment with which we have accomplished the above mentioned results.

It was created or constructed of much discarded material and a few minor purchases, the result of authorized experiments, looking to the use of a large amount of sheet asphalt pavement taken up and removed for the construction of a street railway, and collected on a vacant lot. From an abandoned crematory steel smoke stack (4 feet in diameter) two ten-foot sections were cut. Of one section a drum or cylinder was made and a shaft was run thru the center and supported on journal boxes, enabling the drum to be readily revolved. The usual spider and loading chute were constructed at one end and a discharge opening next to the outside of the circle was cut in the other end. The drum was mounted above a brick firebox or furnace, in length about 18 inches shorter than the drum. Above the brick work a portion of the stack, Section No. 2, was used to inclose the furnace over and around the drum. A 5-h.p. motor furnished power thru reduction gears and chain drive to revolve the drum at the rate of 12 revolutions per minute. The loading chute terminates in an elevated platform, from which an incline leads to the ground. The inside of the drum has fixed to its sides spiral vanes so arranged that they propel the material as the drum revolves. Towards the unloading end it has several proportionately larger movable vanes or doors so arranged that the material is propelled in a direction opposite to that set up by the fixed vanes, or when willed in the same direction. When set to work against the fixed vanes the movable doors, one of which terminates at the unloading opening, prevent the material from coming out of the drum, and keep it well and evenly distributed thru its length. When otherwise set the material is rapidly propelled towards the unloading end and thru the discharge opening into a waiting cart. The movable doors are connected by rods and maintained in parallel position. They are operated by small handles attached to the doors, protruding thru the discharge opening, and are held in the desired position by simple spring catches. The change of doors from one position to the other is made when the doors are at the top of the revolution, being then free of material. This improvised apparatus erected for experimental work has served for nearly three years, making over and serviceable for use a large amount of old material.

It has also produced a considerable quantity of new binder and surface mixture. For the latter purpose, however, we have lately added a standard 9-cubic-foot asphalt pug mixer, a sand bin and chain elevator with which we produce with more certainty new sheet asphalt surface mixture or binder, the drum of course being used to heat the sand or stone.

You will note the dual nature of the plant, its adaptability for making over old material or producing new standard mixtures as desired.

Before attempting to use the old material we determine

NEAR VIEW *of the intersection of Main and Bank streets, resurfaced with old material,* 1913, *showing ¾-inch binder stone, an unusually large percentage of which exists in the mixture, revealed by traffic.*

by analysis the sand grading, particularly with reference to the 100 and 200-mesh material, also the amount of asphaltic cement that it contains, a desirable tho not absolutely necessary procedure, for if the amount of A.C. is unknown a simple substitute of the pat paper stain with a little experience will fairly well determine an excess or deficiency of asphalt. Adding from 1 to 2 per cent. of new asphalt (120 penetration Dow machine) to take the place of that lost during its previous existence on the street, and that which suffers injury in the reheating process, and ocasionally a small amount of portland cement, we have produced mixtures which, carefully watched for over two years, still evidence life and durability. Many chemical analyses before and after indicate live bitumen in amount corresponding to that contained in the old mixture plus that added. The average of a large batch of old material used during 1913-14 showed a bitumen content of 9½ per cent.

Upon the addition of 2 per cent. by weight of new asphaltic cement and reheating, the same material analyzed 11 per cent. bitumen, the complete analysis being as follows:

Bitumen	11.06 per cent.
Passing No. 200 sieve	11.01 per cent.
Passing Nos. 100 and 80 sieves	23. 2 per cent.
Passing Nos. 50 and 40 sieves	32.84 per cent.
Passing Nos. 30 and 20 sieves	19.34 per cent.
Residue on No. 10 sieve	2.13 per cent.
	100.00

There is undeniably a certain volatilization of the lighter oils of the asphalt as evidenced by a slightly hardened mixture. The presence of steam, generated from the moisture nearly always contained in the old material piled in an open lot, has, in my opinion, a tendency to prevent burning or "coking" and leads to better results than otherwise would be obtained.

The old material broke in lumps from 4 to 5 inches in size, binder adhering, is wheeled up the incline, loaded into the drum and allowed to remain from 12 to 15 minutes. Investigation has revealed the fact that the old mixture disintegrates in the drum, not by a gradual peeling off of thin outer layers of each lump, but by sudden dissolution or breaking down of the whole mass, in from 5 to 7 minutes. A wood fire maintained as uniformly as possible heats the mixture in the length of time mentioned to 300 degrees. It has proven possible to regulate the temperature to within a few degrees of the desired heat by timing, each batch being carefully timed in and out of the drum and temperature recorded.

With the original apparatus we made 11,000 sq. yds. of repairs during 1913-14 entirely of old material at the rate of 150 to 200 sq. yds. per working day, and have recorded but few failures.

A similar device will, in my opinion, serve for the initial "Asphalt Repairs for Small Municipalities." It will make serviceable for use old surface mixture. It will produce new surface mixture and binder in limited quantities. Time and experience will dictate when the addition of the "pug mixer" will prove advantageous. For ordinary repair work for small municipalities it has with us proven its practical value and efficiency.

A normal day's run for the plant is exhibited in the following summary taken from the reports of the plant foreman and paving foreman respectively, September 30, 1915, the work being the removing, reheating and relaying of a portion of Granby street, one of our principal thorofares:

INTERSECTION *Westover avenue and Thetford street, residential section. Resurfaced with old material,* 1914.

Plant Foreman's Report—
9 loads (18 boxes, 7 cubic feet) new binder.
24 loads top.

Street Foreman's Report—
Laid 225 square yards 1½-inch top.
Laid 115 square yards 1-inch binder.

Material and time for day's work as follows:

Binder material, per square yard	$0.105
Top material (A.C.), per square yard	.010
Fuel, per square yard	.033
Plant and tools, per square yard	.050
Labor and haul, per square yard	.204
	.402

Several intersections and other short stretches of streets have been taken up, reheated and relaid for test purposes, bith with and without binder, photographs of which I submit herewith, giving the location and year relaid. To date, neither cracks nor other unfavorable signs have developed. The renovated pavement softens under the summer sun and shows slightly the markings of traffic. It has behaved in such a manner as to inspire confidence in its endurance.

Of the 480,230 square yards of sheet asphalt in Norfolk, 20 per cent. of it with an average life of fourteen years, must soon be resurfaced, having deteriorated to a point where further repairs are impracticable. The present surface must be removed, reheated, with the addition of sufficient A.C. and, if required, dust, to convert it into an acceptable sheet asphalt surface mixture, and then relaid, or the entire street surface hauled away to be used in part only for repairs. The problem is one fraught with many uncertainties and difficulties. I am not ready to admit that a practical solution is not to be found in the re-use of the old surface, and to this end intend shortly the building of a larger, more substantial and better mechanically designed plant, along the lines of our first efforts, with a capacity of from 60 to 80 square yards of 2-inch surface per hour.

The question is, can a material sufficiently uniform, stable and durable be produced, justifying the expenditure of 40 cents per square yard, which I estimate will be the total cost when handled in large quantities?

STREET REPAIR *in* CLEVELAND, OHIO

This detailed article on the street repair system in operation in Cleveland, Ohio, is in part by P. J. Masterson, Superintendent of Streets, and also contains information supplied by Mr. Masterson, J. W. Fraser, Superintendent of Asphalt Plants, and others. Its main subjects are the plan and detail of the routine work of the department, extending to the supply of materials, the use of motor trucks and the economy of the same, the asphalt plant operated by the department, the amount and cost of street repairs done with the plant and the methods of keeping the men interested in sustaining the quantity and quality of work turned out by them. In all these lines the methods employed and the results secured are well worth study.

There are three great causes of wear and destruction of streets, viz., street openings, traffic and weather.

The one outstanding feature in earth street repairs which makes impossible any exact recommendation as to the material and method to be adopted for any particular purpose, is the controlling effect of local conditions and the character of the material available on the method by which the work should be accomplished. In this city there are large sections of territory where the earth is of a waxy clay substance, where the streets are a mixture of clay and loam which it is impossible to keep in good condition during wet weather by the usual method of rounding up and opening gutters. These sections are Collinwood, Nottingham, the newly annexed part of Euclid Village, and Rockport Village. Such soil is usually hard to drain effectually, particularly where the district is flat and without sufficient natural drainage. For these streets there is little hope that the surface will remain in good condition for any length of time, or during a continuous stretch of dry weather. Such method of repairing dirt streets is only valuable for a short time and must be repeated from time to time in order to keep the dirt surface in reasonable condition for traffic, by the periodical use of the road machine or drag.

While all but a few streets between the Public Square and E. 55th street are paved, there are many alleys in this section which are not paved, and which our division is constantly called upon to repair and clean up. We find upon investigation that most all complaints about these alleys are on account of rubbish and garbage. While practically all our work for our dirt street gangs is east of E. 55th street, it makes it very expensive to constantly move these gangs in to take care of these alleys, not saying anything about the delay in rounding up dirt streets. Most of these alleys are too narrow for our road machines, and all this work must be done by hand. For sanitary reasons alone, all these alleys should be paved.

In the ordinary routine of the division, districts for storing supplies have been established in various parts of the city. In a few cases the Fire and Police Department properties were used to some extent for supply depots, altho in every case the space was limited.

SUPPLY STATION YARDS.

The following are the supply stations in various parts of the city:

East 76th street and Dell avenue (main yards); basement of City Hall; Theresa Court; East 34th street and Pisek avenue; East 9th street and Lakeside avenue; East 24th street and St. Clair avenue; E. 40th street and L. S. & M. S. R. R.; Aspinwall avenue, Collinwood; old Nottingham Town Hall; Dupont avenue and East 109th street (the Glenville Filtration plant); Police Station No. 13, East 80th street and Superior avenue; Fire Station No. 29, Superior avenue and East 105th street; Fire Station No. 11, East 91st street and Walker avenue; Fire Station No. 25, Broadway and East 71st street.

West Side: West 25th street and Columbus road; along Walworth Run at West 25th and West 55th streets; West 52nd street and Detroit avenue(Ohio state property), and at Police Station No. 12, corner of West 83rd street and Detroit avenue.

At the headquarters for the dirt street gangs on the East Side, 75th and Dell avenue, we maintain our asphalt plant, together with four White motor trucks and other machinery. At this yard we also keep on hand our reserve stock of materials. This store yard is adjacent to the general water works store yard, from which we frequently requisition needed supplies such as water pipe, etc.

At the above yard, we keep on hand five to eight kinds of paving brick (about 500,000 during the repair season). This stock is composed of Buckeye, Newburgh, Cleveland, Medal, Shale, Malvern, Metropolitan, etc., as we make a practice of repairing a certain type of brick street with that special type of brick. We also keep a reserve stock of a special repair brick made especially for repair work. This repair brick is a trifle narrower than the regulation and is used in the making of joints, thus rendering unnecessary the splitting of regulation sizes.

At our main yard, we also keep a large stock of Medina block for repair purposes, which measures 5 inches instead of 6 inches, so as to allow for wear on stone. At this same yard we maintain the following stocks:

Tar—Two carloads.

Cement—Two carloads.

Crushed Stone—Four carloads.

Pelee Island Sand—Ten carloads. This sand, which is secured from Put-in-Bay is a trifle coarser than lake sand and is used for grouting.

Asphaltic Cement—Three to four carloads.

Limestone Dust—Two carloads. This material is secured from Kelly Island and is used to fill voids in lake sand. Fully 95 per cent. of this material will pass a 200-mesh sieve.

Lake Sand—Thirty-five carloads.

Bank Sand—Five to six carloads.

Findlay Stone—Two to three carloads. This grade is harder than the ordinary crushed stone.

Sandstone Curbing—One carload of Buckeye Berea undressed always on hand.

Lumber—200,000 feet No. 1 Norway pine, used in construction of gutter boxes, steps, etc.

Fence Posts—100. These posts are of cedar and are used along embankments, culverts, dead-end streets, etc.

Calcium Chloride—Season's supply. Used in hastening setting of cement grouting, thus permitting traffic in streets six to seven days earlier than heretofore.

Bolts, Oils, Repair Parts, Nails, Coal, Coke, Silica Sand, Etc.—In sufficient quantities to meet all demand.

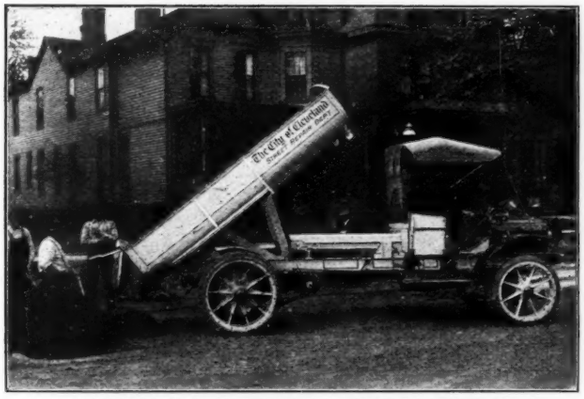
At above yard we store and maintain three Buckeye

asphalt fire wagons, two Kelly-Springfield 5-ton steam rollers, two Buckeye surface heaters, fifteen Indiana road scrapers, four Galion and Indiana road drags, hand rollers, No. 3 American grinder, repair forcing jacks, two Syracuse rooter plows, fourteen regulation Syracuse plows, full set of blacksmith equipment and repair machinery, etc.

MOTOR TRUCKS AND PLEASURE CARS.

A five-passenger Hupp is maintained for use of superintendent in keeping in touch with repair work in different parts of the city, as well as for transporting small gangs, with tools. A Ford runabout is used by H. C. Erdman, assistant superintendent, and is fitted with a special tool-box for transporting of sharpened tools. Another Ford, similarly equipped, is used by the superintendent of paving repairs. A late model Harley-Davidson motorcycle is used by the assistant general foreman. This machine is equipped with package carrier, which is used for the rapid transporting of small tools, such as chisels, etc. Six twin-cylinder Thor motorcycles are devoted to the use of three timekeepers, two inspectors and the general foreman of the asphalt plant. Two Harley-Davidson motorcycles are used by the general foreman of cross-walks and the inspector of street obstructions.

Five White three-ton dump trucks are maintained for transporting of asphalt to repair jobs in all parts of the city. Two of these trucks were purchased in 1913, one in 1914, two in 1915. Four of them are used exclusively for transporting asphalt while one also serves as a carrier of brick, stone and other materials from the main yard to the smaller yards in different parts of the city. These trucks, which are equipped



CLEVELAND STREET DEPARTMENT *hauls asphalt for street repairs in a three-ton White truck.*

with Goodrich De Luxe wireless (European model) tires in front and Kelly-Springfield block tires in rear, do the work of three to four teams each. A team costs $4.80 per day, consequently the saving to this department thru truck operation is easily $5 per day. The average daily cost of truck operation is approximately $5 per day. Not only is there a considerable dollars and cents saving in truck operation, but the added feature of more actual work accomplished in the same length of time. As stated these truck not only transport materials from the main to the smaller yards, but transport material to repair jobs in all parts of the city.

MOTOR TRUCK HAULAGE.

Not only do the trucks carry greater loads than horse-drawn wagons, but they cover ground in speedier fashion. The saving in time alone is considerable, as will be noted by the following distances between the main and smaller municipal store yards:

Collinwood yard	8	miles
Nottingham yard	11	miles
24th and St. Clair yard	4	miles
Theresa Court yard	4	miles
W. 73rd and Denison yard	2½	miles

We have experienced no trouble in operation of our trucks and attend to all minor repairs at our main yard. We use our own men as drivers, placing trucks in charge of those who show liking for mechanics. These now are held responsible for condition of truck at all times, are paid a salary of $70 per month. An accurate record of cost of operation is kept of each individual truck.

In view of the fact that our repair jobs are widely scattered, we attribute our low cost, per square yard, in a large measure, to efficient motor truck haulage of asphalt. The Superior viaduct job, consisting of 4,620 square yards of 2-inch, one-course treatment, was fully two miles distant from the asphalt plant, The actual cost of material and labor, including ripping up of old pavement and removing of rubbish, together with haulage of new material, as well as depreciation on all machinery, was $2,191.32, or 54½ cents per square yard.

OUTPUT OF ASPHALT PLANT.

Our asphalt plant, as described in this article, is used exclusively for repair work. Its output from April 13 to June 1, 1915, is as follows: 1,495.5 tons asphaltic mix, 35½ days worked, $4,839. 79 material used, $1,255.02 labor operating plant, 18,009 square yards resurfaced, $2,808.82 cost of laying.

PLANT.

	Tonnage.	Plant Labor.	Material.
April 13 to 15	77.55	$85.91	$254.85
April 15 to 30	434.05	393.22	1,499.61
May 1 to 15	587.7	407.32	1,872.51
May 15 to 31	392.2	368.57	1,212.82
Totals	1,495.50	$1,255.12	$4,839.79

STREET.

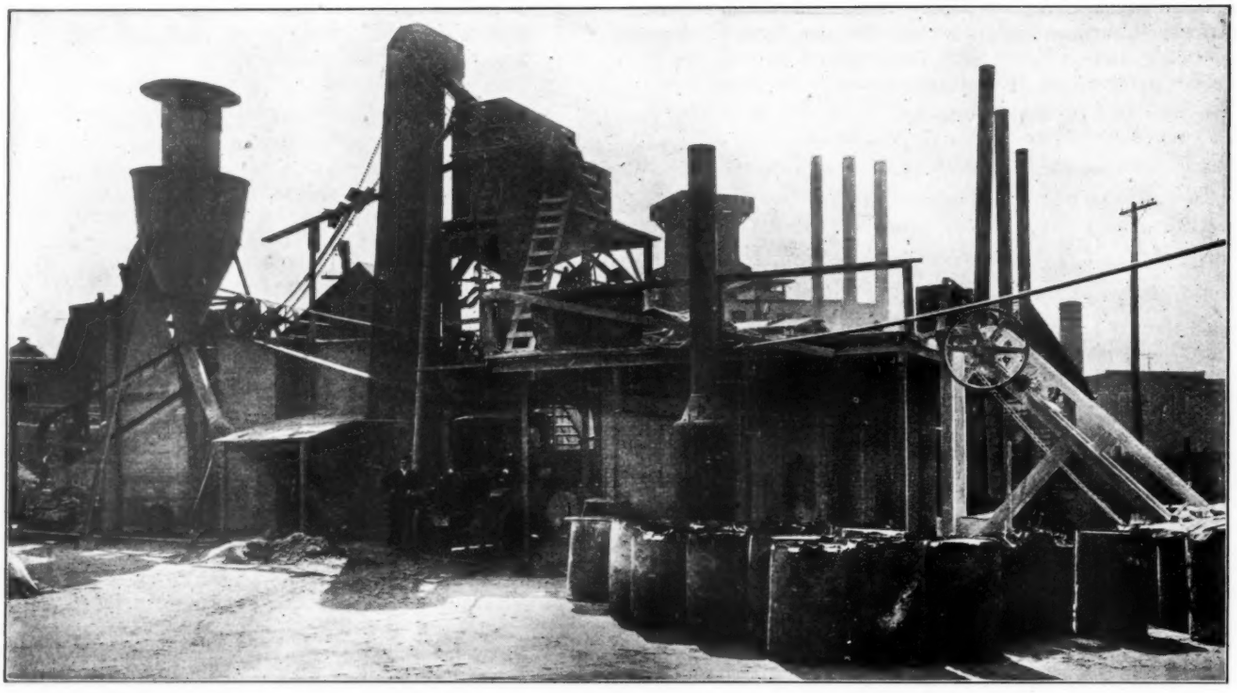
	Yards.	Cost.
April 13 to 15	789	$153.81
April 15 to 30	5,010	834.18
May 1 to 15	7,409½	1,067.02
May 15 to 31	4,800½	753.76
Average tonnage per day		42
Average yardage per day		507
Street labor per yard		$0.15½
Average cost per ton surface mix delivered		4.21
Plant labor and salary truck men per ton		1.00
Cost of hauling, including depreciation of trucks, plant and roller per square yard		.10

DESCRIPTION OF ASPHALT PLANT.

The stationary asphalt paving plant for the city of Cleveland was designed and furnished complete, including foundations, by the F. D. Cummer & Son Company, Cleveland, Ohio. The plant was designed to have an easy capacity for turning out 1,500 square yards of completed sheet asphalt paving (1-inch binder and 2-inch wearing surface) per day; or the equivalent of asphaltic concrete, asphalt macadam or Topeka specifications. The plant is arranged so that any of these asphalt mixtures can be turned out equally well, and without changing the plant in any way. This feature makes the plant especially adapted for a municipality which necessarily has various kinds of asphalt pavements to lay, as well as keep in repair.

The principal units of this plant are:

A Cummer dryer with an easy capacity for drying and heating 25 tons of sand or stone per hour, and coal is used for fuel. This dryer is housed in a brick setting, lined with



CLEVELAND *Municipal Asphalt Plant. General view showing loading platform at the right, with asphalt containers in foreground, elevator conveyor and bins in center, dust collector at the left.*

fire brick, similar to a boiler setting. This machine is very substantially built with heavy steel gearing and has a cylinder of special design on the Cummer principle, 60 inches in diameter and 27 feet long.

The hot sand and stone storage bin has a holding capacity of 20 tons. It is located directly over the mixer, and is divided into two compartments. The sand and stone is delivered by a steel encased elevator into a revolving screen at the top of this bin. The screen separates the sand and stone into their proper compartments, and the tailings, consisting of over-size stone and foreign matter, is discharged by gravity into the weighing box which rests on a three-beam scale.

The Cummer asphalt mixer is steam jacketed and has ten cubic feet capacity with 3-inch square shafts and steam operated gate. There is ample head room and width under the mixer for auto trucks to pass under it.

There are three open asphalt melting kettles, each with 350 cu. ft. holding capacity. They are made of ⅜-inch plate and each is provided with a hinged, rain-proof cover. The asphalt is discharged by gravity into a steam jacketed, electrically welded pressure kettle or lift, which delivers the asphalt automatically to the mixer platform. Each kettle is provided with a small furnace, in which staves or bituminous coal is burned. There is a specially constructed fire brick arch between the grate bars and the kettle bottom, which protects the kettle bottom from burning out.

All asphalt piping is 4 inches in diameter, steam jacketed with 5-inch pipe. The asphalt cocks are all steam jacketed. There is a 22-inch diameter inlet dust collector, made of No. 18 galvanized iron. One 9½-inch Westinghouse air compressor furnishes the necessary compressed air for operating the gate under the mixer, and for agitating the asphalt in the kettles. The power for operating the complete plant is furnished by a 50-h. p. Westinghouse electric motor.

PLANT RECORD APRIL TO SEPTEMBER.

Record of operation April 13th to September 15th:

Number of days operated		122
Total tonnage turned out		5,762
Number of square yards repaired		58,714
Cost of labor operating plant	$4,232.53	
Value of materials used	17,028.47	
Total cost of 5,762 tons delivered		$21,361.00
Total cost of street labor		10,420.14
Total cost of repairing 58,714 sq. yds.		$31,781.14
Cost per ton delivered		$3.71
Cost per square yard complete, exclusive of depreciation on equipment, interest, and truck maintenance		54.1c

Equipment Value.

One Cummer asphalt mixer	$10,600.00
Four 3-ton White trucks at $3,605.00	14,420.00
Two 5-ton steam rollers at $1,675.00	3,350.00
Three fire wagons (tool heaters) at $115.00	345.00
Two surface heaters at $175.00	350.00
One penetrometer	60.00
Chemical apparatus, sand sieves, scales	25.00
Tampers, rakes, shovels, miscellaneous tools	150.00
Total value	$29,300.00
Maintenance and operation charges of motor trucks, per month	$125.00

(In this connection please note there is no idle season for these trucks, as when not hauling asphalt, they are engaged on other classes of work.)

The city of Cleveland includes today 2,149 streets, comprising 530.6 miles of paved streets and 322.4 miles of so-called earth or dirt streets.

Mileage of Paved Streets in Cleveland.

Vitrified block	397.0 miles
Medina stone	100.0 miles
Sheet asphalt	24.8 miles

Limestone macadam	2.4 miles
Tar macadam	1.8 miles
Asphaltic concrete	1.4 miles
Wood block	1.4 miles
Concrete	1.0 miles
Bitulithic	0.4 miles
Total	530.6 miles

Care and maintenance are almost as important matters as selecting and laying the material for a pavement. This matter has received less attention than it has deserved in the past by the committee on appropriations.

If a pavement be kept in constant repair its life will be very much longer than if neglected and only the dangerous depressions taken out or such repairs made as the funds of the division will permit. No one will admit that when a street is newly paved it is a permanent improvement. The only permanency in street pavement is repairs. This condition holds good today and always will.

From a study of the condition of pavements that have been laid in front of parks, cemeteries, churches, etc., where street openings are not often necessary, I believe that as a whole, street pavements are damaged 20 per cent. of their worth by these street openings. This estimate may seem large, but I believe it is a conservative one.

In order to have the streets in good condition at all times, it is not only necessary to repair them with the proper material and in the proper manner, but there should be sufficient funds provided to keep them thoroly in repair, both on account of the damage caused by wear and tear, and also that caused by street openings for subsurface work.

STREET REPAIRING DURING 1914.

The value of street repairs made in 1914 amounted to $353,053.65. Of this amount there was collected through the paving permit fund $146,108.09, leaving a net total to the street repair division of $206,945.56.

Summary of Street Repairing During 1914.

	Charged to Street Repair Fund.	Charged to Paving Permit Fund.
Paved streets	$143,906.59	$137,543.62
East Side dirt streets	38,904.67	1,856.72
West Side dirt streets	19,066.75	618.24
Crosswalks on dirt streets	5,067.55	145.01
Puddling	.....	5,944.50
Total	$206,945.56	$146,108.09

There were 1,854,412 square feet of pavement laid or relaid during 1914, of which the cost of 963,875 square feet was borne by the street repair division, the remainder being charged against the paving permit fund.

Summary of Paving Repairs During 1914.

Kind of Pavement.	Filler.	Sq. Ft. Charged Street Repairing.	Sq. Ft. Charged Paving Permit.
Medina dressed block	Tar	292,786	333,113
Medina dressed block	Cement	5,210	26,879
Medina common stone	Tar	12,271	22,796
Medina common stone	Sand	23,773	124,417
Medina common stone	Cement	7,543	1,734
5-inch brick	Tar	78,103	31,639
5-inch brick	Cement	165,758	139,414
4-inch brich	Tar	63,384	23,693
4-inch brick	Cement	43,641	36,865
Shale brick	Tar	41,543	20,606
Asphalt	.....	158,098	62,429
Macadam	.....	70,789	29,152
Binder for asphalt	.....	500	.....
Concrete	.....	476	37,350
Asphalt block	.....	.....	450
Totals		963,875	890,537

In addition to the foregoing there were 6,652 lineal feet of crosswalk laid or relaid on paved streets; 7,879 feet of curbing set or reset; 452 feet of flagging relaid, and 7,301 feet of curbing cut down for driveways.

Kind of Work.	Charged to Street Repairing.	Charged to Paving Permit.
Crosswalk laid or relaid	3,715 Ln. ft.	2,937 Ln. ft.
Curbing set or reset	917 Ln. ft.	6,728 Ln. ft.
Combination curbing and crosswalk relaid	....	234 Ln. ft.
Curbing cut	15 Ln. ft.	7,286 Ln. ft.
Flagging relaid	....	452 Ln. ft.
Totals	4,647 Ln. ft.	17,637 Ln. ft.

Summary of Cost of Paving Repairing from Street Repair Fund.

Brick and stone work	$105,439.69
Asphalt surface	14,431.75
Slag macadam	5,550.60
Other miscellaneous	18,484.55
Total	$143,906.59

Detail of Cost of Brick and Stone Repairing.

(a) *Material.*

Medina dress block	26,022 sq. ft. 25c	$6,505.50
Medina common stone	5,490 sq. ft. at 10c	549.00
5-inch brick	414,976 at 2½c each	10,374.40
4-inch brick	189,161 at 2c each	3,783.22
4-inch shale brick	50,717 at 1c each	507.17
Tar for brick pavement	183,030 sq. ft. at 1c	1,830.30
Tar for stone pavement	305,057 sq. ft. at 3c	9,151.71
Cement	4,104 sacks at 40c	1,641.60
Fine sand	4,103 sacks at 15c	615.45
Curbing (old	432½ ft. at 25c	108.13
Crosswalk (old)	15 ft. at 25c	3.75
Crushed stone	5,850 lbs. at $2 ton	5.85
Paid J. R. Burnett for resetting curbing		6.75
Total cost		$35,082.83

(b) *Labor.*

Kind of Pavement.	Filler.	Feet Laid.	Cost.	Approximate. Unit Cost.
Medina stone	Tar	305,057	$25,082.30	8.2c
Medina stone	Sand	23,773	1,764.47	7.4c
Medina stone	Cement	12,753	1,172.64	9.2c
5-inch brick	Tar	78,103	6,292.31	8.0c
5-inch brick	Cement	165,758	13,386.23	8.0c
4-inch brick	Tar	63,384	4,900.52	7.7c
4-inch brick	Cement	43,641	3,720.07	8.5c
Shale brick	Tar	41,543	3,177.91	7.7c
Crosswalks	.....	3,715	364.32	9.8c
Curbing	.....	917	178.61	19.5c
Concrete	.....	476	27.52	5.8c
Total cost			$60,066.90	

(c) *Teaming.*

Kind of Pavement.	Feet Laid.	Cost.	Approximate Unit Cost.
Tar and sand-filled pavement..	511,860	$6,105.99	1.2c
Cement filled pavement and concrete	223,545	4,183.97	1.9c
Total cost		$10,289.96	

The success we have had in our municipal asphalt plant is due to two facts:

First: Up-to-date methods at the plant, on the street and in hauling material;

Second: The aggressive spirit and morale of the individual members of the outfit.

At the plant we aimed first to produce nothing but standard surface and binder at a minimum cost. This required the closest kind of watching, both of the raw material and our product.

As is customary we started buying sands from different places and blending them in the required amounts to obtain the correct gradings at the plant. While on the whole this was done in a satisfactory manner, yet there was a certain amount of wasted energy used by the plant foreman that could be used to better advantage on the mixing platform. However, we arranged with one of the sand companies, who dredge lake sand from different parts of the lake with corresponding variations in grading, to mix the sand to our order when loading. Thus by keeping in touch with the sand company we are able to avoid any dependence upon the plant laborers.

In addition we test each car upon its arrival, make three platform tests of the sand daily and one of each kettle of asphaltic cement before it is used. Each car of asphaltic cement is tested upon arrival as well as the lime dust used as filler. By the way, our limestone dust runs 98½ per cent. material passing a 200 mesh screen.

All crushed stone must also stand hardness and grading tests.

DAILY REPORTS FROM PLANT AND STREET GANGS.

A report of the plant showing the production with the amounts and costs of materials is made out daily. These are totaled for the half month and the average per ton cost compared with the previous semi-monthly reports.

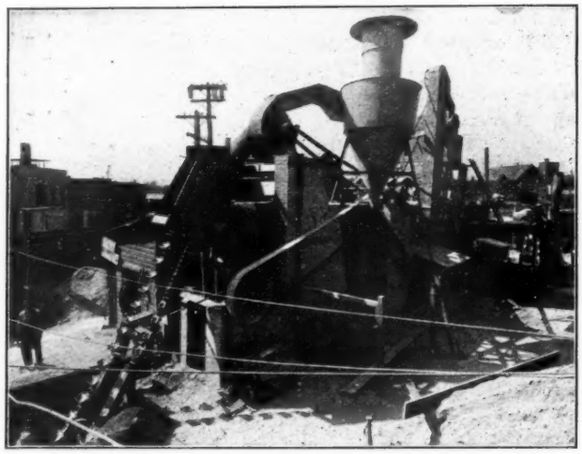
On the street we have two gangs. Each foreman's report shows the cost of his labor, the amount of material used and yardage laid. Their material is delivered to them at an average cost per ton, regardless of their location, giving both equal opportunity in their costs.

Their daily reports are, as in the case of the plant, duly noted, and any unseemly variation in their costs inquired into and properly explained or corrected. Semi-monthly, as in the case of the plant, an average cost is obtained and compared with previous semi-monthly reports.

A spirit of friendly rivalry has been fostered between the two gangs and its effectiveness is shown in the low labor costs on the street.

DUMP ADJOINING PLANT.

The quick and effective hauling of material and rubbish has been obtained by the use of auto-trucks. This fact is the all-important feature of our organization. When a load is hauled to the street quite necessarily on patchwork a load of rubbish must be removed. This is done entirely by our trucks. As soon as a load of material is dumped at its proper location the truck is immediately reloaded with rubbish and unloading at the dump does not run over eight to ten minutes.



CLEVELAND MUNICIPAL ASPHALT PLANT. *View showing elevator for sand, end of dryer cylinder, and dust collector.*

In this connection I might say that the effectiveness of the trucks. As soon as a load of material is dumped at its proper willingness and get-there spirit must be shown at all times, as the opportunity to waste time is greater on a truck than in practically any other position. For this reason, we have practically all young men, without exception men who were without truck experience before we got them. This does not mean that we have not had experienced truck drivers. We have had many such, but for some reason they could not fall into the proper spirit and it was necessary to let them go and substitute men who would follow more closely our plans.

In short, the success of the Cleveland municipal asphalt plant is due to an aggressive organization with a proper spirit of doing things better and cheaper than the next fellow.

OPERATING COSTS ON AUTO TRUCKS.

Auto-trucks are all White Company 3-ton trucks with bodies especially designed for asphalt purposes. The bodies consist of two plates separated by one-half- inch layer of asbestos. On top of above a wearing plate of No. 10 gage steel is placed. This plate can be renewed when worn. The side walls of the body meet the bottom by a 6-inch radius, leaving no sharp corner for the material to lodge and stick.

Newer trucks elevate to a 50 degree angle, the three older ones, however, elevate to a 45 degree. We intend this winter to change the elevation to 50 degrees on the balance of the trucks as there is a decided saving in time in the newer trucks.

Average mileage	.42
Average cost per day for motor sundries, includes oil, gasoline and tires, per truck	2.22
Average cost per day for repairs.....	1.88
To which add driver's rate, average per day.....	2.46
Which is charged on plant report.	
Total operating cost, per day.....	$6.56
To this can be added the depreciation and interest on investment of 16 per cent., per day.....	1.87
Grand total	$8.43

Extended over the average yardage gives an added cost for trucking of .047c per square yard.

QUESTION DEPARTMENT

Books on Municipal Engineering

I am city engineer at this point and am looking for the most up-to-date works on street pavements, sanitation, sewerage and water supply. Kindly advise me if the McCullough's work goes into detail, giving sketches, plans, cross-section work and estimates. I would be much pleased if you can furnish information that will lead to my getting a publication going into the above mentioned subject. R., ———, Minn.

McCullough's "Engineering Work in Towns and Small Cities" ($3) is the only book which gives connected views of the work covered by the city engineering departments of small cities and towns and contains also much detail which is of value. It is perhaps the best book to read as an introduction to a thoro study of city engineering and can be used as a guide book to such study. A long list of books treating in full of each of the subjcts to which Mr. McCullough devotes a single chapter or a part of a chapter will be given if desired. Such analytical lists were printed in MUNICIPAL ENGINEERING some years ago and they will be brought down to date if any number of our readers request and name the subjects to be covered.

Best Way to Set Water Meters

Will you kindly send me any data in regard to the best way to set water meters. We wish to provide in our ordinance for the proper setting of meters as those we have in use are very difficult to get at.

D., City Engineer, ———, Ill.

Unless meters are set outside the buildings it is difficult to make a rule such as would be necessary in an ordinance which will fit all cases. If the ordinance already provides for the setting of meters, whether for every service or for certain classes of services, it should provide at the same time for the setting of the meters by the city water department or under its direct supervision and control, and that the meter shall be so located as to be readily accessible for reading, testing, removal, and repair, and that authorized water works employes shall have uninterrupted access to the meters for such purposes at all reasonable times. Also the meter and the way to it should be kept clear at all times so that it will not be necessary to remove materials to reach it. Protection from freezing should also be provided for.

If, as is generally considered the best policy, the city owns and sets the meters, many of these requirements need not be put in the ordinance, the requirement of free passage and of payment of damage to meter or pipes by the property owner probably being sufficient.

But the simplest solution of the problem is to put the meters in meter boxes set outside the buildings or even outside the lots, under sidewalks or in street lawns. While such boxes may be more expensive than setting the meter in the house without due reference to safety from injury, as is so often the case, the saving in time of meter reader, in cost of repairs to meter and pipes, and in damage from freezing will more than pay the interest on the investment.

Setting of meters on vertical pipes either in buildings or in meter boxes is possible where the exposure to frost is not too dangerous.

The following articles in recent volumes of MUNICIPAL ENGINEERING, describe methods of setting meters in buildings and in outside boxes:

In vol. xlvi: "Importance of Meter Inspection," p. 158; "Vertical Meter Connection," p. 88; "Advantages of the Outside Installation of Water Meters," p. 42.

In vol. xlv: "Prevention of Meter Freezing," p. 395; "Location and Setting of Water Meters in New Orleans," p. 280.

In vol. xliv: "The Clark Meter Box," p. 573.

Other articles in earlier volumes describe still other devices and discuss the proper provisions for ordinances requiring meters, who should pay for meters, the proper charge for meters when the water works installs them, and related subjects.

Provisions of Contract for Paving and Its Surety Bond

This town is about to pave a portion of its principal street with brick laid on a cement foundation. Specifications have already been prepared by the engineer.

I am writing to know if you have any form of contract specially adapted for such work on account of its technical nature. If you have, I shall appreciate a copy. Also a copy of a bond to be given by a surety company for the faithful performance of it.

M., Town Solicitor, ———, Pa.

The technical part of the contract from the engineer's standpoint is contained in the specifications and the plans for the improvement, which should be referred to in the contract as a part thereof. The legal part of the contract takes its form according to the statutes of the state in which the town is located and may even be determined to some extent by special laws affecting the class of towns or the individual town.

Surety companies doing this class of business have forms covering the points usually required. The town solicitor should see that the form used really binds the surety company to take up and finish the contract in case the principal fails, to pay any damages or expenses which may result from delays or failures to comply with the contract, to pay any valid claims for damages from accidents on or connected with the work for which the principal can be held responsible, to defend any suits brought against the city on account of the contract or the manner of carrying it out and to pay any judgments against the city in such suits and to pay the expenses of the city in the same in case the principal fails to do any or all of these things as specified in his contract.

WORKERS IN THE FIELD

The Motor Truck and the Contractor

The Editor of MUNICIPAL ENGINEERING:

Sir—Taking into careful consideration all of the many ideas that have been developed and brought into use for the economical work of the contractor and road builder, nothing has in any way approached or compared with the motor truck equipped with hoisting body. This has now been brought down to such a science that the stone or whatever material is being hauled not only can be placed on the road from either short or far distances in the quickest possible time and be dumped in fifteen to twenty seconds, but the connection between the hoisting body and the forward and reverse movement of the truck is so perfected that the material may be spread in any desired thickness at the same time it is being dumped.

Basing on actual results, observations and reports from our many customers, we have found that, outside of cases where the owners overdid and thoroly abused the proposition, there has never been anything brought to their attention that makes the tremendous saving in time and expense of the present equipment. We do not believe that this side of the question would be argued by anyone. The savings have come to a point where the average time in which you can positively pay the entire purchase price of one of these trucks, based on the difference between the costs of men and teams and the same amount of work done by the truck, is nine months. In other words if the same payroll or expense that would have to be paid out to the owners for hauling the road material a given length of time be continued and applied as saved on the purchase price of motor trucks to haul the same tonnage, the savings alone in nine months, on the average, would pay the investment. That would leave the owner of the trucks an opportunity to go over them during the winter months, and his trucks would then cost him nothing for the next two or three years, so that the value of them would amount to that much additional profit on his work.

It is a conceded fact now that road contractors who have thoroly equipped themselves with the modern motor trucks with hoisting bodies can bid lower to the extent of the cost of these trucks in obtaining their contract. But before we show the manufacturer's side, allow us to say that wherever you find a contractor whose experience has been otherwise than stated above, you can absolutely trace it to two causes. One is in the inefficient methods that he has pursued in the managing of his motor trucks, another is in his mis-use of the trucks, which were not designed or built of material to stand the work to which he puts them. In no machinery ought as much care be taken as of a motor truck.

One side of the question, which has never been brought out to our knowledge by any of the magazines, is the fact that so many road contractors, who want to take advantage of the tremendous savings, go to the manufacturer, (and we will grant that they are led by many truck salesmen, who will go to almost any extreme to sell their trucks, to believe that these things can be brought about and their idea is in the first place to get the price of these trucks down below the actual cost of their production, and then they insist that the manufacturer sell them on long time payments. Now, let us see the other side. We manufacturers have been the pioneers to bring about this great evolution in transportation, and our pioneer efforts have cut the roads thru that have made all this possible. This has been brought about thru the expenditure of vast sums of money and many failures that have been costly. The present purchasers of trucks have never contributed one single dollar towards this large fund.

The building of our plants to produce these trucks has meant a large investment of cash. Our machinery has meant another large outlay of money and our materials must be paid for. Unless we take advantage of cash discounts, we are unable to get our costs down to a point where we have a margin left for our efforts. Our pay rolls have certainly got to be paid or we immediately go out of business, therefore the financing of our side of the question is a heavy problem.

Now, after producing a piece of machinery that brings to the contractor the tremendous profits that he must admit are there and gives him the opportunity of having this wonderful chance at no extra investment at all, by simply the paying of what he spends in payrolls and costs to teams on which he never gets any returns, turned into the payment for these trucks, the contractor without any seeming thought of this side tries to purchase and insists on wanting to buy these trucks on long time payments, or in other words, asks us manufacturers to finance his business. If the present prices are ever to be materially reduced it must be brought about by allowing the manufacturer to produce his goods on a less investment of actual cash.

A contractor may say that it is impossible for him to put up the lump sum for these trucks at one time, while he can spread out his payments to the teams in pay rolls over the period of nine months.

However, he can get the advantage of a liberal cash discount by going to his banker and borrowing the money, making his arrangements to pay to the local banker the same amount of money every month that he would be paying out to the teamsters. In that way, his notes to the bank would be constantly reduced until they are finally wiped out without any effect on his part, and at the end of the time his truck would stand him nothing. The truck manufacturer will be giving the truck to the contractor at a lower price, as he, being able to obtain the cash thru his bank is in position to obtain his cash discount, and thereby bring about a satisfactory arangement to all concerned. The truck manufacturer is besieged from all sides with expenses, and we believe if

these thoughts would be more seriously taken up and gone into, far better results would be obtained.

Don't forget that any truck manufacturer who offers you high-grade dumping trucks on long terms and extremely low prices is in a position where thru the inferiority of his article he is compelled to go to these limits in order to sell his product and that the customer in the end will pay dearly for what seems to him accommodation.

B. A. GRAMM,
Vice President and General Manager
The Gramm Bernstein Co., Lima, Ohio.

Illumination of Charleston, W. Va.

One of the first installations of the new type of pendant luminous arc lamps was recently made at Charleston, W. Va. The lamps are equipped with prismatic glass refractors. system of lighting in this city may be divided into three classes: "White Way," or ornamental lighting, in the business section; intermediate lighting in the residential section, and suburban lighting.

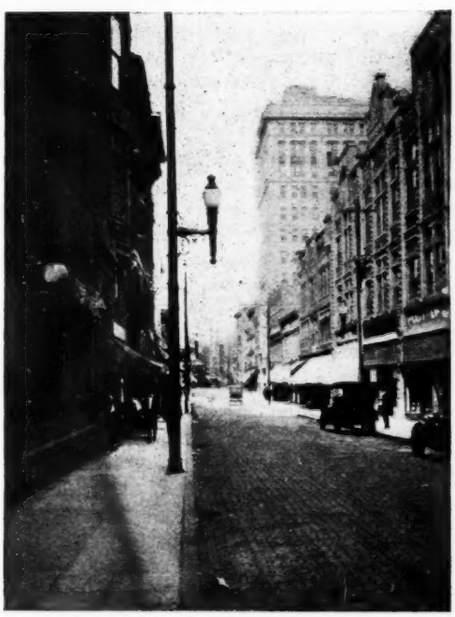
In the "White Way" section are installed sixty-two 4-amp. ornamental luminous arc lamps, using high efficiency electrodes and equipped with fine texture Alba globes. The lamps are mounted on ornamental brackets, supported on steel trolley poles, with overhead line construction. The poles are spaced approximately 120-ft. apart on each side of the street, and are staggered. The elevation of the lamps is 16½ feet from the curb to the arc.

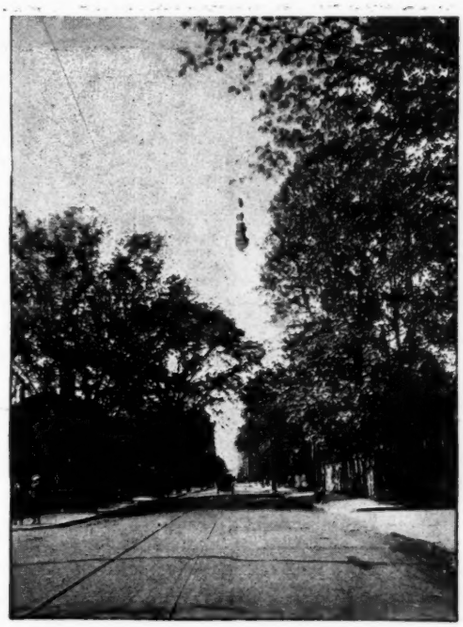
With this spacing a wonderfully well-diffused and brilliant daylight effect is produced, with an entire absence of shadows, and on account of the peculiar shape of the globe, considerable light is projected upward, which illuminates the fronts of the buildings from the pavement to the cornice. This soft and well-diffused distribution of bright light is particularly effective and practical for business sections.

In the residential sections and thruout the greater part of the city pendant luminous arc lamps with refractors and operating at 4 amperes are employed. These are hung from 22 to 25 feet above the street, at street intersections, which spaces the lamps from 300 to 400 feet apart. The refractor type of lamp, on account of its extensive distribution of light, is especially adapted to such spacing, and a remarkably even illumination is produced on the street surface. Both the center-span and mast-arm suspensions are used, in conformity with the physical requirements of different localities.

In the remaining outlying portions of the city and in suburban sections where the use of large units is not warranted, low wattage series incandescent lamps are employed, mounted on brackets and equipped with radial wave reflectors. The entire system is operated from fifty-light, double-tube, series rectifier sets.

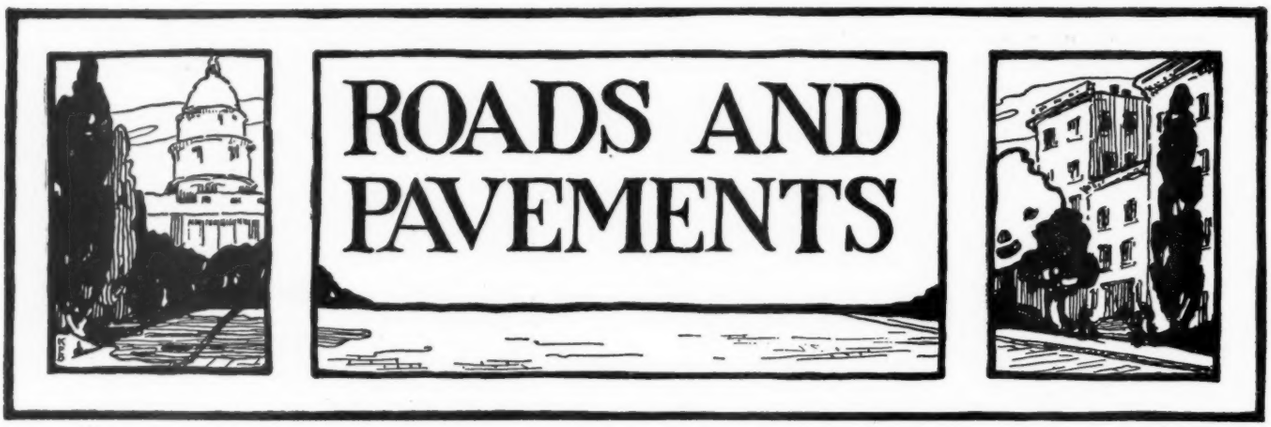
ORNAMENTAL LUMINOUS ARC LAMPS *in business sections of Charleston, W. Va.*





PENDANT LUMINOUS ARC LAMPS, *center-span suspension, in residential sections of Charleston, W. Va.*

PENDANT LUMINOUS ARC LAMPS, *mast-arm suspension, in residential sections of Charleston, W. Va.*



Increase in Use of Concrete for Country Roads

The mileage of concrete pavements in the United States has increased rapidly, and it is likely to continue to increase, according to a new bulletin of the United States Department of Agriculture. This bulletin gives the estimated amount of concrete pavement in the United States in 1914 as 19,200,000 square yards; in 1909 it was only 364,000 square yards.

The principal advantages of concrete pavements which have led to this increase in popularity are said to be:

1. Durability under ordinary traffic conditions.
2. A smooth, even surface offering little resistance.
3. Absence of dust and ease with which it may be cleaned.
4. Comparatively small cost of maintenance until renewals are necessary.
5. Availability as base for another type of surface if desirable.
6. Attractive appearance.

In commenting upon these advantages, the bulletin states that the durability of concrete roads has not yet been proved by actual practice, because there are no very old pavements as yet in existence, but from the condition of those which have undergone several years' service, it seems probable that they will be found to wear well.

The disadvantages of concrete as a road surface are:

1. Its noise under horse traffic.
2. The wearing of the necessary joints in the pavement, and the tendency to crack, with its consequent rapid deterioration.
3. The difficulty of repairs when these become necessary.

In the past efforts have frequently been made to overcome these objections to a certain degree by covering the concrete pavement with a bituminous wearing surface. At present time the specialists in the Department of Agriculture hold that this can not be economically justified altho it is possible that future investigation may change the situation in this respect. In the present state of road science, however, it seems that where traffic conditions are such that a bituminous surface on a concrete road is practicable a bituminous-surface macadam road would be equally practicable and certainly cheaper. Where traffic is too heavy for macadam road the bituminous surface is likely to give way and the uneven manner in which it fails tends to produce excessive wear on portions of the concrete.

For a successful concrete road, hardness, toughness and uniformity are the most essential qualities. These can be secured to a great extent by care in the selection of the constituent materials and the proportions in which they are mixed. Sample specifications are included in the bulletin, No. 249, "Portland Cement Concrete Pavements for Country Roads." These specifications are believed to typify the best engineering practice as it has been developed up to this time. They cover such points as materials, grading, sub-grade and construction.

The cement, it is said, should always conform to some standard specifications for Portland cement, such as those issued by the United States Bureau of Standards or the American Society for Testing Materials. The sand should not contain more than 3 per cent of foreign material, and sand with more coarse than fine grains is to be preferred. The coarse aggregate may consist of either crushed stone or gravel. In either case it is very desirable that the coarse aggregate be well graded in size between proper limits.

The proportion of cement to the sand and coarse aggregate combined should not be less than about 1 to 5, and the proportion of sand to coarse aggregate not less than 1½ to 3, nor greater than 2 to 3. A useful formula when gravel is used as coarse aggregate is 1 part of cement to 1½ parts of sand to 3 parts of gravel. When crushed stone is used, 1¾ parts of sand may be substituted in place of 1½ parts.

In addition to discussing the engineering details of construction, the bulletin already mentioned calls attention to the fact that ordinarily from one-third to one-half of the total cost of constructing a concrete pavement is for labor after the materials are delivered. This emphasizes the importance of efficient organization and proper equipment. Failure to take these factors into consideration frequently results, it is said, in adding from 10 to 20 per cent to the cost of a concrete pavement.

The most economical method is to have the work of mixing and placing the concrete as nearly continuous as practicable. The work should be planned with a primary view of keeping the mixer going full time. The drainage structures, the grading and the sub-grade should, therefore, be completed well in advance of the mixer and provision made for obtaining all of the necessary materials without delay.

New Concrete Pavements on Cook County Roads

Milwaukee Avenue, Cook County, Ill., is one of the most important thorofares in the state. It is the artery of a large system of county roads and an outlet from an extensive truck gardening district tributary to Chicago. In the height of the season hundred of farmers travel the road daily, hauling tons of garden produce to the city. Nor is travel on this highway limited to farmers. The traffic census shows that the average travel during week days is 1,500 cars and on Saturdays, Sundays and other holidays as many as 4,000 cars traverse this thorofare. It also offers a popular road over which merchants deliver goods to outlying portions of Chicago and suburbs beyond. The road now has the longest stretch of concrete road in the state of Illinois. It will soon be extended to the Cook County line and it is hoped that the entire road to Milwaukee will be improved with hard surface pavements within a very few years.

Increased Radius of Curb at Street Corners

At most street intersections the radius of the curb at the street corner is such that a motorist desiring to turn the corner finds it impossible to describe an arc of turn that will enable him to maintain a moderate rate of speed and still keep his machine on the proper side of the pavement while turning into the cross street. The radius of the curb curve is usually but little over a foot, hence the driver cannot commence to turn until he has practically passed the corner. Increasing the radius of the corner curve up to say, 12 or 14 feet, will permit most types of cars to turn a corner at the same distance from the curb as when driving down the street.

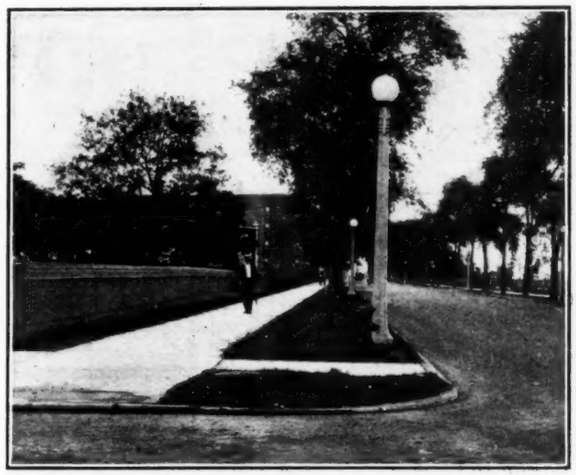
Changes such as suggested by the accompanying sketch have been made at several street intersections in Chicago, notably at Lincoln Parkway and Diversey Boulevard, and at Devon and Evanston Avenues.

How materially the possibilities of making the desired turn within the proper confines are facilitated will be seen by referring to the sketch. The double dotted lines show the curb at the usual street corner, while the double solid lines back of these illustrate what has been accomplished at the two localities mentioned—the change at Lincoln Parkway and Diversey Boulevard being shown in an accompanying photograph.

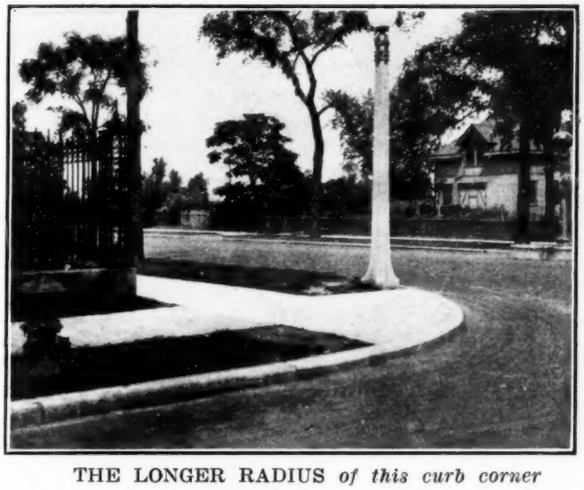
The increasing radius of the curve, as shown by the solid lines permits the driver to follow the arc of the curb and thus keep to the right of the center line of the street where he properly belongs. This is clearly illustrated by the line C. With the sharp corner a driver running at the same speed and turning on a curve of the same radius must cross its center line and could not pass two cars coming toward his as indicated by the arrows B.

Such an improvement is particularly desirable on boulecards or where other streets intersect with boulevards. It is likewise desirable at intersections of narrow streets. This subject deserves the attention of engineers in charge of street improvements, and the practice suggested should be universally adopted, if for no other reason than to increase safety.

Street corners in Indianapolis are long-standing illustrations of the value of these suggestions. Nearly 25 years ago the standard minimum radius of curb corners was adopted as 6 feet, and at intersections with very wide streets or with boulevards the radius is still longer, being in some cases as great as 20 feet. Radius of curves at alley intersections is 4 feet.

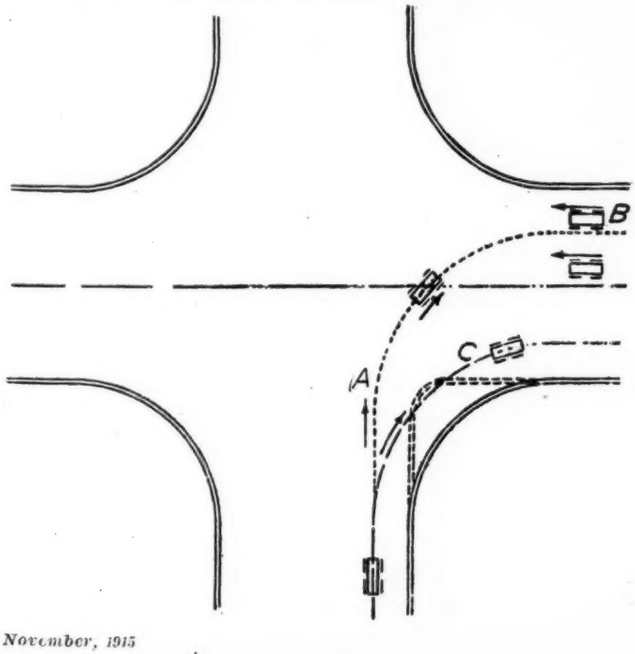


SHORT RADIUS OF CURB CORNER *does not permit the automobile to turn at usual speed and keep on the proper side of the street.*



THE LONGER RADIUS *of this curb corner allows the automobiles to turn parallel to the curve of the curb, as shown by the wheel marks visible on the pavement.*

SKETCH SHOWING EFFECT *of curb corner of small radius in throwing automobile across the street in making the turn, whereas the large radius curb permits automobile to keep to right side of street, with same speed of travel.*



If sidewalks are set back near the property lines, as shown in the photographs, the curb corner radius can be equal to the narrower width of the space between sidewalk and curb without interferring in the least with foot traffic and may usually be considerably longer. This is clearly shown in one of the accompanying photographs. In the other photograph, where the sidewalk is brought to the rounded curb line in the intersection, is indicated the point of difficulty. In this particular photograph there is no difficulty and the curb corner can have a radius equal to the whole width of sidewalk and lawn, but

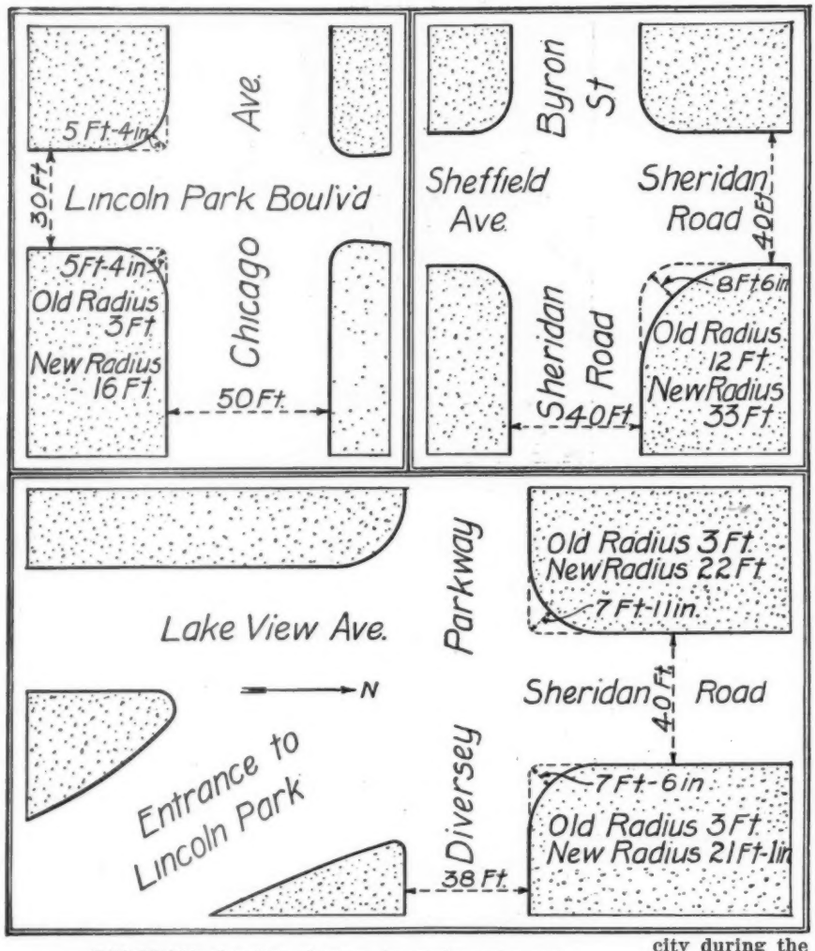


DIAGRAM *showing changes in curb corners at important boulevard intersections and park entrances to improve facilities for turning corners and appearance of streets.*

when inlets for surface drainage are located at or near the corner, the depth of curb or position of inlet may require straight curb where the sidewalk comes to it, thus limiting the radius of the curb corner to the width of the lawn space between sidewalk pavement and curb.

If drainage is designed at the same time as curb lines this difficulty can usually be met satisfactorily.

Experimental Paving in Cleveland

By Maurice Brown Greenough, Instructor in charge of Highway Engineering, Case School of Applied Science.

The City of Cleveland, in co-operation with Case School of Applied Science, has inaugurated a program of experimental and observational paving for the purpose of determining what type of brick and stone block pavement construction is best adapted to use in that city. East Sixty-fifth street, Claasen, Perkins and Clement Avenues have been chosen for this work, and with the exception of the last named, all of these have been opened to traffic. Clement avenue will be completed in the near future.

The table presented herewith shows the amount and character of the work.

About 600 feet of Clement avenue will be built by the standard method as represented by section one of East Sixty-fifth street, but in the remaining 600 feet the standard sand cushion will be replaced by a mixture of sand and bituminous material.

In the Claasen avenue pavement there have been placed nine empty monument boxes about 12 inches square and extending thru the base, affording means for studying the action of frost on the base of the pavement. These are set in rows of three, one at each side of the street and one on the center line, each row being 100 feet apart. This is in accordance with the plan previously announced.

Perkins avenue has been open to a heavy traffic for three months. While there is a distinct line of demarkation between the old portion of the pavement and the new, and the new is one-half inch higher, aside from a slight wearing off on the exposed edge of the brick there has been no breaking down of the pavement as a whole.

East Sixty-fifth street has been open only a short time, hence any definite statements as to comparative wearing qualities are at present impossible.

Considerable interest attaches to the monolithic type of construction and it is probable that more will be laid by the city during the coming season.

The specifications for Perkins avenue were drawn by the paving department of the city, those for East Sixty-fifth street by the bridge department, since that street is on a fill coming ing within their jurisdiction.

Robert Hoffman is commissioner of engineering, Mr. Richards, engineer of bridges, Joseph P. Bayne, superintendent of paving, and Fritz Reich is chief inspector for the city.

Public Service Commission Cannot Increase Franchise Rate for Street Railway Fare

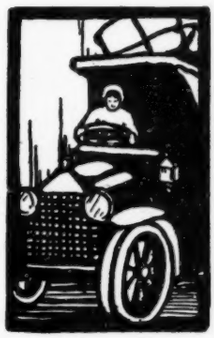
The New York Public Service Commission, Second District, decides that it is not authorized to fix a rate of fare on a street railroad higher than that limited by the local authorities as a condition of granting the franchise whereunder such railroad was constructed and is operated.

Interstate Highways

The International Pavedway is a newly projected transcontinental highway, proposed to extend from Detroit thru southern Michigan, Indiana, Illinois, Missouri, Arkansas and Texas, passing thru St. Louis, Little Rock, Dallas, Austin and San Antonio to Laredo, Texas, on the Mexican line.

Street	Length	Surfacing	Filler	Cushion	Foundation
East 65th	44 feet	5 inch brick	Cement	1½ inch. Sand	6 inch plain concrete
East 65th	99 feet	5 inch brick	Cement	None	4 inch reinforced concrete
East 65th	265.5 feet	5 inch brick	Cement	None	Natural earth
East 65th	98.5 feet	5 inch brick	Mastic	None	Natural earth
East 65th	100 feet	5 inch brick	Pitch	None	Natural earth
East 65th	25 feet	Medina St.	Cement	None	4 inch reinforced concrete
Perkins	About 1500 feet	4 inch brick	Cement	1 inch 1-4 sand-cement	6 inch plain concrete

MOTOR VEHICLES



Recent Developments in Fire-Fighting Apparatus—Comparative Statements of Costs of Operation

The Ford Motor Company thru its Long Island City branch, recently filled an order for twenty "fire-fighting Fords" for the fire department of the City of New York. The cars were officially presented to a score of battalion chiefs, who are to use them hereafter in getting to fires in a hurry.

The cars are all runabouts, in official department red, and with eight-inch clapper bells mounted on the dashboard by a steel yoke. On the side of each car is the number of the battalion to which it has been assigned.

Some little sentiment is connected with the bells on the new cars. They were cast in the department repair-shop from large bells used in Kings and Queens counties before the time of Greater New York, when each engine-house had a bell. The metal in them was of purest quality, and they were made by expert bellmakers from Europe. It is said that modern bellmakers are unable to imitate their clear sound, but the little bells carry the exact ring and tone of their ancestors.

Before the Ford cars were accepted for the official cars, they were obliged to undergo a thoro test, directed by department officials. Each car had to prove its ability to travel thirty miles an hour. The average time for the twenty cars was about thirty-eight miles per hour. The hill-climbing ability was shown on Abey Hill, a 16 per cent. grade one-third of a mile long, which the Fords took at an average speed of eighteen miles per hour.

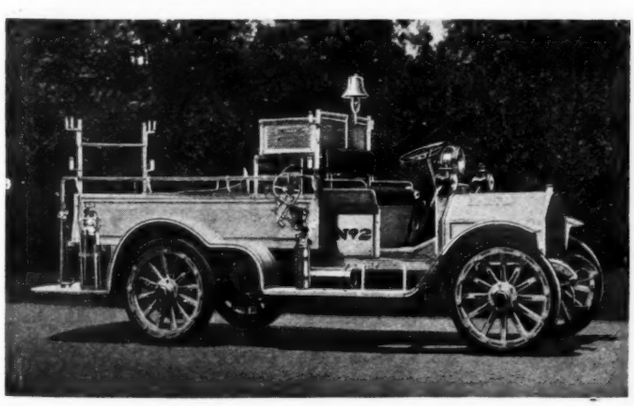
The economic side of the Ford car as a part of the fire department is interesting to the great body of taxpayers. Estimates by statisticians of the New York department place the saving made possible by a Ford runabout over a horse-drawn vehicle at $450 a year.

Formerly all the battalion chiefs drove thorobred horses, and the annual cost of maintaining one of these animals, including forage, shoeing, veterinary charges, stable equipment, etc., amounted to about $300. The initial cost of the horses was about $350 and their life seven years, making the depreciation per year $50.

Repairs and depreciation for each buggy amounted to another $50 with the total cost to the city for equipment for one chief officer with two horses standing at $650 annually. In a Ford runabout these items are eliminated or reduced until the expense is about $200, a clean saving to the city of $450 per year.

Previous to securing the score of "mosquito fire fighters," as the Ford cars are called, the New York department had twenty-seven Ford cars, and is contemplating the addition of forty more in the very near future. The installation of Ford cars is but a step in the complete motorization of the New York fire department.

FEDERAL *Combination Chemical and Hose Truck, City of Littleton, Colo.*

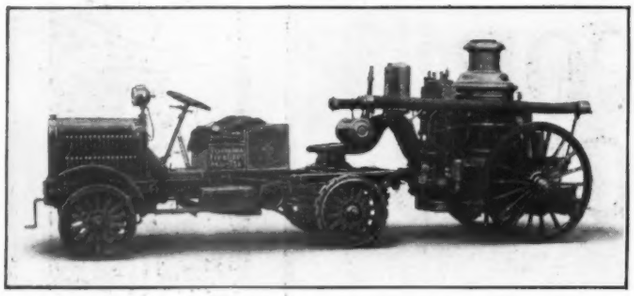


GREATER EFFICIENCY AT LESS COST.

Fire Chief W. J. Nemeck, Douglas, Ariz., supplies us with the following statistical costs relative to operation and maintenance of two Seagrave combination chemical and hose wagons for first twelve months of service. "During the first year," states Chief Nemeck, "the two motors used 293 gallons of gasoline at an average rate of 17 cents per gallon, or $46.20 for the year. Approximately $20 worth of oil was used during the year. Most of this fuel was used in instructing the firemen and in running the motors twice daily, at noon and 5 p. m., when house practice takes place. The only renewal during the year was the purchase of one spark plug at the cost of 75 cents. Previously the four horses which drew the steamer and ladder truck cost $800 annually to keep. During the year 52 runs were made. This total includes fire calls, false alarms and practice runs. The efficiency of the auto apparatus is indicated in other ways. In the horse-drawn days 1,000 feet of 2½ inch hose was carried. Now 2,400 feet is hurried to every downtown alarm and almost that amount to any alarm inside the city limits. The old apparatus carried 190 feet of ladders. The new and old combined carry 240 feet. The firemen now have 170 gallons of chemical fluid and 700 feet of chemical hose at their disposal, as against 70 gallons and 300 feet under the old regime. The contract price for the two machines is approximately $11,000."

NEW PUMPING ENGINE AND HOSE CARRIER.

The City of Independence, Kas., has received its motor-driven pumper, furnished by the South Bend Motor Car Works, South Bend, Ind. This outfit, which is known as P 140, is a combination pumping engine and hose carrier, propelled by a 5¾ by 7-inch 6-cylinder 140 h. p. Wisconsin motor. A Stewart-Warner gasoline system is used. Bosch and Atwater-Kent ignition systems work independently of each other. Transmission is Bosch-Driggs-Seabury with a



WICHITA 3½ *ton Tractor, City of Texarkana, Tex.*

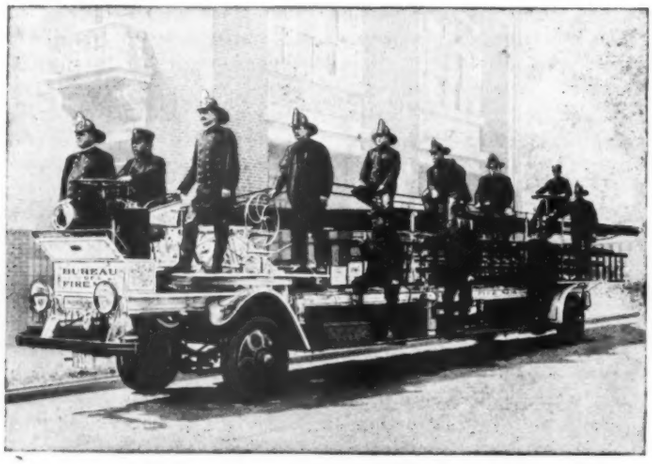
Hele-Shaw multiple disc clutch running in oil. The wheel base of this car is 162 inches, with Sewell cushion wheels equipped with Goodyear 38x4 dual rears, and 38x6 single fronts. The hose carrier has a capacity of 1,200 feet of fire department standard 2½-inch rubber-lined hose. This car carries a Rumsey rotary geared pump with a throwing capacity of 800 gallons of water per minute. The pump is driven from the main transmission shaft to a second set of gears and two changes of gears are provided. Shifting lever for throwing pump into engagement is operated either from the driver's seat or from the ground. The pump is fitted with a Larkin relief valve. The alarm equipment is one 10-inch locomotive bell, and one 8-inch siren placed on the dash. The equipment further consists of one 35-ft. trussed extension ladder, one 12-ft. single ladder, one 12-ft. roof ladder, one 12-ft. pike pole, two axes, four Dietz lanterns, one Detroit door opener, two Babcock fire extinguishers, one crow bar, one Eastman deluge set, one siamese coupling for two lines of hose from the hydrant to the pump. The weight of the car less men and hose is approximately 8,500 pounds.

NO PROVISION FOR HORSES.

Chicago's fire department at present is about 22 per cent. motorized. It has 68 motors and 259 horse-drawn vehicles. Due to the lack of funds, it is not probable that any material increase in motor fire apparatus will be made this year. As much preparation as is possible under present conditions is being made by the department for the complete motorization of the equipment. New firehouses that are being built are designed without provision for horses and those that have to house horses are so arranged that the stalls can be ripped out easily.

The fire motors that are already in use in the city have proved their value time and again. An accurate estimate of the amount of money they have saved the city in expense of operation has not been made, but it is stated that probably $90,000 would cover it.

COUPLE GEAR *Aerial Ladder Truck, City of Philadelphia, Pa.*



TEN NEW MOTOR PATROLS.

Police Commissioner Waldo of the city of New York recently awarded a contract to the R. & L. company, eastern Garford agents, for ten more Garford motor-driven patrol wagons. The following statistics, taken from the annual report of the police department are extremely interesting and afford a reliable means of comparison between motors and horses:

SOUTH BEND *Double Duty Ambulance, South. Bend, Ind.*

Three motor patrol wagons were purchased and placed in service during 1912, replacing nine horse-drawn patrol wagons, and effecting a saving as shown below:

1911	
Boarding 21 horses at $30 per month	$7,560.00
Shoeing 21 horses at $5.50 per month	1,386.00
Repairs to 9 patrol wagons $35 per year	315.00
Repairs to 9 sets of harness $5 per year	45.00
Eighteen patrolmen's salaries at $1,400 per year	25,200.00
Total	$34,506.00

1912	
Automobiles kept in station house	
Tires 48, at $37.05 each	1,778.40
Gasoline, oil and grease	595.00
Nine patrolmen's salaries at $1,400 per year	12,600.00
Total	14,973.40
Saving	19,532.60

BOYD *Aerial Ladder Truck, City of Philadelphia, Pa.*

HORSE VS. MOTOR PATROLS.

A comparative statement covering cost of operation of a horse-drawn patrol and a Franklin motor-driven patrol, furnished by the City of Syracuse, follows:

Horse-drawn Patrol Twelve Months.

Feed and bedding	$ 703.00
Veterinary fees	68.50
Horse shoeing	237.65
Supplies	543.04
Three drivers at $75 per month	2,700.00
One stableman	720.00
	$4,972.19
Number of calls	3,706
Average cost per month	$414.34
Average number of calls per month	308
Cost per call	$1.34

Franklin Patrol Twenty-eight Months.

Gasoline	$ 289.60
Oil	123.08
Charging Presto-O-Lite tank	182.50
Repairs—result of being run into by another machine.	33.70
Miscellaneous expense other than above (including painting and general overhauling $207.62)	370.06
Tire expense (including cost of five shoes, $283.30)	384.38
Chief operator at $80 per month	2,280.00
Two operators at $65 per month	3,705.00
	$7,368.32
Number of calls	9,715
Average cost per month	$258.54
Average number of calls per month	341
Average mileage per day	25
Cost per call	$0.74

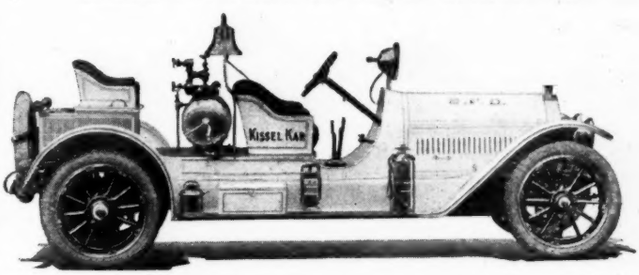
FEDERAL *Fire Department, Service Truck, City of Portland, Ore.*

Fire Department Notes

George C. King, the chief of the fire department of Monrovia, Cal., for the past three years, saw his first service in the Rochester (N. Y.) volunteer fire department, for which was built to order the first hose wagon of the style of today, from ideas of Louis Rice. Later he helped develop the fire department of Oneida, N. Y., from a hand engine, jumper hose reel, hook and ladder truck and triangle alarm bell of old railroad rails to its present state of high efficiency. He has been an exempt fireman for years, but could not keep out of the harness when he went to Monrovia, some eight years ago.

Frank D. Grimm, chief engineer of the fire department of Franklin, Pa., has recently succeeded in adding two pieces of motor-driven apparatus to his equipment. On his recommendation also the city has installed a four-circuit board with storage batteries and a generating set together with some additional fire alarm boxes. Mr. Grimm has been chief engineer for eleven years.

KISSEL *Fire Chief's car, City of Madison, Wis.*

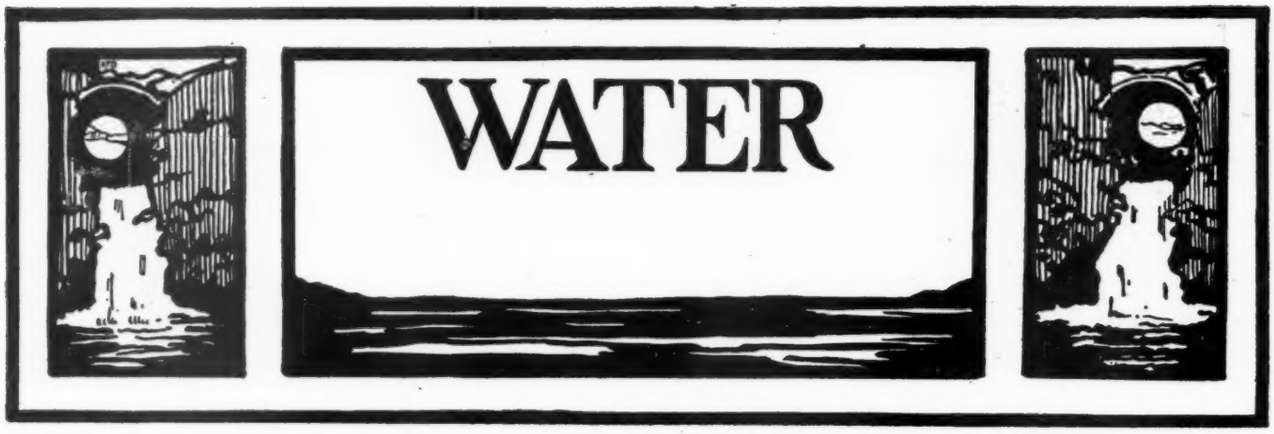


F. C. Miller, chief of fire department, Centralia, Wash., writes that he expects within the next year to place an additional piece of motor apparatus in service. The department at present has in service one motor combination chemical hook and ladder truck. The city has recently established fire limits and passed several ordinances pertaining to fire protection.

Fred B. Larrabee, chief of fire department of Hardwick, Vt., a town of 2,000, writes that through the recent installation of a Gamewell fire alarm system, consisting of twelve fire alarms and eighteen tappers, the fire losses in his town have been materially reduced.

John J. Bower, chief of fire department of Bellefonte, Pa., writes that the fire loss in his city since October, 1914, has amounted to $1,068, the total value of the buildings involved amounting to $111,800, with insurance of $97,150, value of contents $25,900 and insurance $16,000.

W. F. Davis, chief of fire department of Pawhuska, Okla., is an ex-cowboy and says that his early training has stood him in good stead as a fire fighter. The total fire loss in Pawhuska for the year was $16,613.00, or a per capita loss of $4.153. The Pawhuska department is not yet motorized, but Chief Davis has recommended that two pieces of apparatus be purchased.



Electrical Apparatus for Thawing Out Water Pipes

Having had numerous requests for information regarding the electrical apparatus in use for thawing ice in water mains and services, and, having demonstrated its practicability and value, W. A. Kellogg, general foreman of the Columbus (Ohio) water works, has prepared the following description of it.

The contemplated purchase of a 2½-ton truck for general use by the department suggested the mounting of a portable thawing equipment, inasmuch as it would only be used during the time of the year the truck would be least wanted for other purposes. The facility for mounting and removing the equipment was unified as far as possible by bolting the various parts to a channel frame 8 inches in depth.

The generator is of 30 kilowatt capacity, direct current, 100 volts maximum, 300 amperes, or 400 amperes at 75 volts; speed, 800 revolutions per minute maximum.

The engine is of 50 brake horsepower at 800 revolutions per minute, 4-cylinder 4-cycle, direct connected to the generator by a flexible coupling. A special governor was designed which permits of governed control at all speeds between 250 and 850 revolutions per minute. Gasoline is used for fuel, supplied under 3-pound pressure from a 26-gallon tank.

A radiator sufficient in area to permit continuous operation of the engine at full load is mounted at the front end of the frame, and an air blast thru the radiator is induced by means of a 24-inch exhaust fan, mounted on an extension of the engine crankshaft, and surrounded by a shroud. Cooling water is circulated by a pump, as is usual in engines of this size.

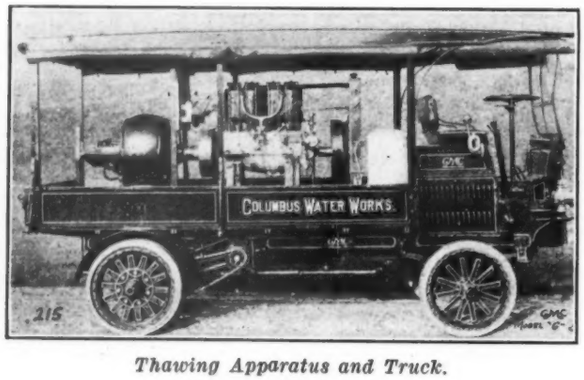
On a switchboard located between the engine and generator are mounted a volt and ammeter, field rheostat, main switch and overload circuit breaker. All the elements of control, both of the engine and the electrical system, are within reach of the operator without moving from one position. Leads are carried from the switchboard fuses to brushes which bear on slip rings mounted on a drum, which in turn is carried on hangers under the right hand side of the truck body. This drum carries two 210-foot lengths of 300,000 circular mill flexible cable, any length of which may be unreeled for making taps, and which is rewound by electric power. Special bronze clamps were designed to make proper electrical contact on any size of pipe between ⅜-inch and 2½-inch by hand nut adjustments and other connections for making contacts on hydrants, bibcocks, etc. All such auxiliaries are designed to be used with hands alone and without tools. The clamps are connected to the cable terminals by hand nuts.

No details were spared which tend to lessen the time consumed in making connections and preparing for the thawing out operations, as this factor is necessarily much longer than the period of operation of the current.

The melting capacity of the plant is 12 pounds of ice at 32 deg. F. per minute. This melting effect is, of course, concentrated on the inside wall of the pipe, producing a skin of water surrounding a core of ice which is quickly melted by the flow of the water itself. The initial melting is, therefore, all that is required of the current; and it is found in practice that as soon as a few drops of water show at the delivery point the current may at once be shut off, as the water will complete the work.

Unless the pipes inside the house or building are frozen, it has been found that the best results are obtained when the connection is made as close as possible to the place of entry of the service pipe into the building. The other cable is connected to a fire plug, if one is within 200 feet, or, if not, to a pipe in a neighboring house.

We are indebted to the General Motors Company, Flint, Mich.., for photograph of the apparatus mounted on one of their trucks.



Thawing Apparatus and Truck.

Temperature and Strength of Concrete

"The Influence of Temperature Upon the Strength of Concrete," by A. B. McDaniel, has been issued as Bulletin No. 81 of the Engineering Experiment Station of the University of Illinois. This bulletin presents a study of the data obtained from three series of tests of concrete cubes and cylinders. The data are presented in the form of curves, which show the relation between the strength and temperature at different ages. This bulletin will be of value to the contractor, engineer and others engaged or interested in construction work for information regarding the strength which may be expected of ordinary concrete under different age and temperature conditions, and the time of the removal of the forms. Copies of Bulletin No. 81 may be obtained gratis upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

MISCELLANEOUS

Dayton Convention of American Society of Municipal Improvements

The Dayton convention of the American Society of Municipal Improvements, held October 12-15 with important open committee meetings on October 11, was the most successful convention the society has held, from every point of view.

The registration was about 60 per cent. greater than at any previous convention. The registration of guests was greater than usual, on account of the convention of the National Paving Brick Manufacturers' Association, who were the hosts of the A. S. M. I. at a banquet on Tuesday evening and the guests of the A. S. M. I. at the sessions of its convention, but the attendance of active and of associate members was greater than usual, more than 40 per cent. of the total membership being in attendance. Losses from members dropped for non-payment of dues and municipal delegates not reappointed were practically made up by new individual members elected.

The interest in the meetings was very great, the sessions of committees and sub-committees and of the convention devoted to paving subjects being specially popular. The discussions were practically continuous in committee and convention from Monday noon until Thursday night at 8, when the afternoon session adjourned, so that no one could complain that he had no opportunity to be heard or that he could not become fully informed before he was called upon to vote upon the specifications presented for adoption. The plan for discussion in sub-committee, followed by further open discussion of the sub-committee's report before the general committee on standard specifications, and this followed by an opportunity to discuss the final committee report on the floor of the convention was strictly followed and saved some time of the convention at the same time that it made the convention's action one based on full discussion and full information.

Interest centered on the two sets of specifications which had not been adopted, those for wood block and for bituminous paving, the changes in the specifications adopted at the Boston convention being but few, except as to those for cement concrete paving. Wednesday evening was devoted to papers on wood block paving, more particularly the treatment of the blocks and the oils for such treatment, and the discussion was continued into the session devoted to standard specifications, but no specifications were adopted, and the one member of the committee present was given instructions to present a set of specifications to publish in the proceedings of the convention which would pay more attention to methods of treatment and of laying blocks and less to the particular kind of oil to be used in the treatment. This is an action which has been recommended by disinterested observers of the controversies over creosote oils and tars for some years, and is a step in the right direction.

Members of the sub-committee on bituminous paving specifications dropped in from day to day until on Thursday morning a majority of the committee was present. Perhaps on this account there was much change in action by the sub-committee, which culminated in a reversal of the report of a majority of the sub-committee on the floor of the convention as it was presented under the general committee. This action of the sub-committee caused a discussion on the floor of the convention, and before the general specifications committee during a recess for the purpose, and the adoption of a report presented by a minority of the sub-committee at the end of a session which lasted from 2:15 to 7:45 p. m. on Thursday. The report as adopted carried specifications for bitulithic pavement and for a bituminous pavement, presumed to be an improvement upon the Topeka specification which the owners of the bitulithic patents agree is not an infringement of their patents.

The sessions devoted to garbage and refuse and sewage disposal, water supply, flood prevention, the Dayton form of government, brick, and granite block paving, municipal legislation and finance and city planning were also of interest and were well attended. The committee on standard forms made a valuable report.

One valuable report was that of the committee on committees. It is necessary periodically to revise the list of committees and issue new instructions, because conditions change and new officers are not familiar with the methods of operation, or introduce new ideas which must be fitted into the plan. This report was prepared by ex-Secretary Folwell, aided by the secretary and Mr. Hallock, who is an active chairman and member of committees and includes a full set of instructions to the chairmen of committees, including the plan for the various stages of the formulation and discussion of standard specifications and changes therein, which was carried out so satisfactorily as to results, at least, at this convention, and emphasizing one requirement, that the sub-committees prepare their reports so that they will be published in the advance papers for distribution to the members before the convention.

The officers elected were A. F. Macallum, city engineer of Hamilton, Ontario, president; Norman S. Sprague, superintendent of Bureau of Engineering, Pittsburgh, Pa., first vice-president; J. B. Hittell, chief engineer of streets, Chicago, Ill., second vice-president; E. R. Conant, city engineer, Savannah, Ga., third vice-president; Charles Carroll Brown, Indianapolis, Ind., secretary; Will B. Howe, city engineer, Concord, N. H., treasurer; E. S. Rankin, Newark, N. J., Matthew Brown, Emporia, Kans., F. J. Cellarius, Dayton, Ohio, finance committee.

The committee on exhibits also reported the largest and most interesting exhibits in the history of this valuable addendum to the convention. The exhibits included:

American City, New York.
Atlantic Refining Co., Philadelphia.
Atlas Portland Cement Co., New York.
Barber Asphalt Paving Co., Philadelphia.
Barrett Manufacturing Co., New York.
Better Roads, Jamestown, Ohio.
Buff and Buff, Boston.
Philip Cary Co., Cincinnati.
Concrete Appliance Co., New York.
D. & D. Safety Cover Co., Minneapolis.
Dunn Wire-Cut-Lug Brick Co., Conneaut.
Engineering Record, New York.
Good Roads, New York.
Granite Paving Block Manufacturers' Association of the United States, Boston.
Hetherington & Berner, Indianapolis.
Indestructible Sign Co.
Ironton Portland Cement Co., Ironton.
Jennison-Wright Co., Toledo.
Lock Joint Pipe Co., New York.
Metropolitan Paving Brick Co., Canton.
Municipal Journal, New York.
National Lamp Works of General Electric Co., Cleveland.
National Paving Brick Manufacturers' Association, Cleveland.
Ohio Quarries Co., Cleveland.
Pierce Oil Corporation, St. Louis, Mo.
Pioneer Asphalt Co., Lawrenceville, Ill.
Republic Creosoting Co., Indianapolis.
Universal Portland Cement Co., Chicago.
United States Asphalt Refining Co., New York.
Warner-Quinlan Co., New York.
Warren Brothers Co., Boston.

The entertainment features of the convention have been reduced to a minimum by the action of the society. This time they consisted of a banquet on Tuesday evening, tendered to the A. S. M. I. by the National Paving Brick Manufacturers' Association, and an automobile ride over the pavements of the city and about the flooded district of 1913, including lunch at the Hills and Dales Club, and ending at the Wright aviation field, where flights by students in the aviation school were observed. Mr. Blair, the secretary of the N. P. B. M. A., provided two excellent speakers in President W. O. Thompson, of Ohio State University, and ex-Governor George B. Cox, of Dayton, whose addresses were received with enthusiasm and made a strong impression. The ladies of the convention were entertained royally by the Dayton Engineers' Club and were kept quite as busy as the attendants at the convention. The society was much indebted to the local committees, in which F. J. Cellarius and J. E. Barlow, members of the society, and E. H. Menter, of the Greater Dayton Association, were particularly active. City Manager Henry M. Waite and E. A. Deeds, chairman of the Miami Conservancy Board, were also contributors of time and effort to the enjoyment and instruction of the convention. Many short trips to places of interest were taken by small parties under the guidance of the local committees and their assistants.

The municipal, county and school budget exhibit, which was in progress in Memorial Hall, was most instructive, and delegates spent much time in studying it, as it showed in detail the methods in operation in the various city departments and the practical results of the new Dayton form of city government.

Technical Schools

On September 27, the University of Illinois laid the corner stone of the new Ceramic Engineering Building, at which ceremony Prof. Edward Orton, Jr., dean of the College of Engineering of Ohio State University, made the principal speech. Prof. E. V. Bleminger has been put in charge of the course in Ceramic Engineering.

The September Bulletin of the University of Michigan contains the proceedings of the short course in highway engineering held by the College of Engineering last February. Earth roads, gravel and macadam roads, bituminous treatment for roads, traffic census, culverts and bridges, organization of road forces, are some of the subjects discussed by experts. The next short course will be held February 21 to 25, 1916, with speakers from the highway departments of several states and the U. S. Office of Public Roads and Profs. I. O. Baker and A. H. Blanchard.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places as follows:

December 8-9: Surveyor, at $125 to $150 a month, and transitman at $100 to $110, in General Land Office with per diem for subsistence.

Calendar of Meetings of Associations

Plans for the national convention of the American Association of Engineers to be held in Chicago, December 10 and 11, are being rapidly completed. All engineering societies have been invited to send official representatives to the convention to join in the discussion and assist in attempts to solve a few of the welfare problems confronting the engineer. Permanent offices are at 29 South LaSalle street, Chicago, Ill.

The Illuminating Engineering Society will hold its next semi-annual convention in New York City in February, 1916. The offices of the society are at 29 West Thirty-ninth street, New York.

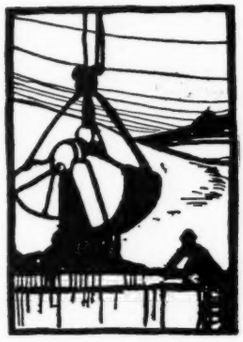
Personal Notes

The City Planning Commission of Allentown, Pa., held a city planning exhibition at the Hamilton Hall, in Allentown, on October 20, 21 and 22. The exhibition was the comprehensive series of photographs, maps and drawings collected and arranged for exhibition purposes by Frank Koester, consulting engineer, New York, who delivered lectures in connection with the exhibit.

J. L. Jacobs, formerly engineer in charge of the municipal efficiency division of Chicago, has opened offices in the Monadnock Block, Chicago, for consultation on, supervision or conduct of efficiency surveys, management, appraisals and cost accounting for industrial or public institutions.

Publications Received

The first number of *The Utilities Magazine*, dated July, 1915, is received. It is published by The Utilities Bureau, created by the conference of American mayors on public policies as to municipal utilities, held in Philadelphia in November, 1914, of which Morris Llewellyn Cooke, 216 City Hall, Philadelphia, Pa., is acting director. Such subjects as the plaintiff's right to examine the books of a public utility company, cost of producing illuminating gas, the New York electric light rate case, jitney bus ordinances are quite fully discussed.



MACHINERY AND SUPPLIES

Asphalt Roadways for Very Light Traffic.

The main types of asphaltic road construction are the "mixed" method and the "penetration" method. In the former a mixture of stone or gravel and asphalt, combined hot, is spread on the foundation and rolled to a thickness of about two inches. The foundation for such roads may be broken stone, old macadam or cement concrete. Concrete foundations are not necessary, except in cases where the traffic is very heavy or where the road traverses unstable ground.

Penetration construction consists in placing the broken stone in the roadway in very much the same fashion as would be followed in building plain macadam, and pouring over it an amount of asphalt sufficient to fill the interstices between the stone, and bond it together. Fine stone chips are then rolled into the surface. A seal coat, consisting of a light pouring of asphalt screened with stone chips, may be applied to give the road a smoother surface.

For all ordinary conditions met with in private estate construction penetration asphalt macadam answers every requirement as to durability and attractiveness. It costs less than mixed method roads, requires no extensive plant for construction and is therefore available everywhere.

The purpose of the asphalt is to bond the stone together, forming a waterproof matrix. It is evident from this that the most satisfactory road will be one in which there is used an asphalt which does not "bleed," volatilize and lose its binding power.

Bermudez asphalt comes from the famous lake of this name in Venezuela. The elements have exhausted their influence on Bermudez asphalt before it is used in road building.

Private estate roads can be constructed with Bermudez road asphalt in such a manner that they will last as long as the buildings to which they provide safe, pleasant and dustless access.

Recourse to the oiling of roads for the purpose of dust laying has proved in many cases to be a cure that is worse than the disease. Light road oils have no power to bond together the mineral aggregate of a road surface, and besides the unattractive appearance of a blackened surface, are open to the serious objection that the oil is tracked into houses, and what stays in the road produces a surface that is slippery and mushy after wetting. In fact, road oiling as ordinarily practiced accomplishes no more than the changing of ordinary dust into greasy dust, which is ruinous to clothes, lawns and gardens, injurious to automobiles, and an offensive nuisance.

As distinguished from road oiling it is possible, given a hard road surface which can be cleaned of dust and dirt, to apply a Trinidad liquid asphalt carpet coat. This is screened with fine stone chips or gravel or with coarse, clean sand, and forms a road crust which is dustless, waterproof and reasonably durable, but not, of course, equal in durability to the permanent forms of construction described above.

There is no bleeding of the bitumen on roads resurfaced with Trinidad liquid asphalt.

Specifications, detailed information and advice respecting particular road problems will be supplied without charge to owners, architects and others who may be interested in improved roadways for private estates, parks or suburban real estate developments by the Barber Asphalt Paving Company, Philadelphia, Pa.

Motor-Driven Lawn Mowers

One of the convenient adaptations of the gasoline motor is to lawn mowers as made by the Coldwell Lawn Mower Co., of Newburg, N. Y. They are used by the part departments in such cities as Boston, Mass.; Brooklyn, N. Y., several in Prospect Park; Buenos Aires, S. A.; New York City, boro of Manhattan; Chicago, Ill., in the various park districts; Cleveland, O., one in each of the principal parks; Denver, Colo., Detroit, Mich.; Elkins Park, Pa.; Forest Park, L. I.; Garden City, N. Y.; Gloversville, N. Y.; Green Lake, Wis.; Hartford, Conn.; Indianapolis, Ind.; Manila, P. I.; Morristown, N. J.; New York, boro of the Bronx; Ottawa, Can.; Providence, R. I.; Seattle, Wash.; Trenton, N. J.

Gas Burning Household Garbage Destructor

The "Incinerite," a gas burning device for the disposal of garbage and other household waste and so largely used by hospitals and other public institutions, has now been taken over entirely by E. C. Stearns & Co., of Syracuse, N. Y., who formerly manufactured the device for the National Incinerator Company of New York City.

The "Incinerite" is employed in the kitchens of the White House at Washington, and in other prominent residences, as well as hotels, restaurants, hospitals, school buildings, etc., thruout the country, but is also made in sizes suitable and practical for ordinary family use.

A novel feature of the apparatus is that it serves not only as an incinerator, but as a waste receptacle as well. All garbage and household refuse, wet or dry, is placed immediately in the "Incinerite." Then the burners are lighted and the combustion, aided by the formation of natural gases in the garbage, soon reduces the entire mass to a handful or two of fine sterile ash. Thus are solved the problems of the garbage collector and the unsanitary conditions arising from even the temporary storage or collection of refuse about the premises. Information is available from E. C. Stearns & Co., Syracuse, N. Y.

The New Little Giant Six-Wheel Truck Construction

Industries having bulky or long but light loads to transport, frequently fail to realize the expected economies of motor truck transportation owing to the very limited loading space which the ordinary chassis affords. In the ordinary four-wheel truck the power is applied thru its traction wheels and motor truck practice is to place the entire load or the greater portion of it directly over or slightly forward of the traction wheels. The traction wheels must therefore both carry and push the load.

In the Little Giant six wheel truck manufactured by the Chicago Pneumatic Tool Co., 1010 Fisher Building, Chicago, Ill., these objections are overcome. The power of the motor is utilized to draw the load instead of carrying it and pushing it, with the result that efficiency of the power unit is doubled. In the six-wheel construction only sufficient of the load is placed upon the chassis of the truck to secure proper traction. But the weight so imposed is not rigidly fastened to the chassis but rests upon a ball race making it a live or floating load. This feature naturally relieves the running gear and engine from the shock and strain which a load ordinarily transmits to a truck as a result of the constant vibration due to irregularities of roadbed, and also affords relief from strain in starting and stopping. This relief from the shock and strain is so great that the life of the motor is naturally increased and has even been doubled.

In the Little Giant six-wheel construction, the rear wheels absolutely track and the driver need have no more concern for the movement and guidance of the load than in ordinary four-wheel construction.

The price of this new truck is low when compared to capacity. The amount of upkeep charges for maintenance, consumption of gasoline, oil, etc., is small. It is able to turn around in a 36-foot space, even when carrying lumber 40 feet long. As an example of its speed, the truck made a trip from Philadelphia to Baltimore, 107 miles, including all stops, in seven hours and thirty-eight minutes.

The Little Giant six-wheel construction is of such a nature that anyone owning a Little Giant truck can purchase the additional outfit with all the apparatus necessary to complete the arrangement and easily apply it, thus making it possible by doubling the load space of the truck to double its carrying capacity.

Any desired details regarding the truck and the success of its operation will be supplied by the Chicago Pneumatic Tool Co., 1010 Fisher Building.

The New Ford Meter Holding Yoke and Expansion Connection

There have just been placed upon the market a new meter holding device and an expansion connection for water meters which are the result of the inventive genius of Mr. E. H. Ford, President of the Ford Meter Box Company, at Wabash, Indiana.

This new yoke is intended to become a permanent part of meter setting as shown in cross-section view herewith. The cover illustrated is of the well-known Wabash double-lid type which has been extensively adopted by water departments for outdoor setting. This new yoke carries recessed ports in which are placed leather gaskets which remain permanently as part of the installation.

Details of the yoke construction are shown in smaller cut. The new expansion connection screws onto spud of meter before being placed in box. Meter and connection can then be

lowered easily into position and connection expanded by a few turns of the hand wheel. It has been found that connection so made will stand against any pressure within the limit of strength of meter shell.

The new yoke is also being manufactured in another form, not illustrated, in which an angle stop valve is placed in either one or both ends, thus doing away with the necessity for the ordinary curb cock and box. These yokes with double valve arrangements are recommended for meter installations where it is desirable to shut off back water from property in case meter is temporarily removed.

With this connection and new yoke the overall dimensions of meter and fittings are reduced to the lowest possible limit, thus adding materially to the frost-proof qualities of the setting.

Gumbo Wheel Excavator Operation

By C. D. and J. T. Pierson, Lewis, Ind.

Our wider experience in marsh soil excavation has proven the all round adaptability of the gumbo self-cleaning excavating wheel. We believe that this type is best suited for work in all kinds of soil. With this type we have put in 5,000 feet in ten hours, with an average of 3,500 feet in ten hours in a two months run in the same field where other types gave up.

During September, 1915, we were working in the worst kind of gumbo muck but averaged 175 rods, 4 feet deep. The same power applied on upland would average 250 to 300 rods per day. In the job just mentioned we encountered a dense willow thicket, 20 feet in height, containing trees at least 8 inches in diameter. These larger trees were chopped off 4 or 5 inches from the ground. In spite of these difficulties, two men and a boy were able to place 25 rods of tile in a 4-foot trench per hour. Three teams were kept busy hauling tile, a distance of one mile, in order to keep up with the machine.

The accompanying table gives operating costs of this machine for a limited period last year.

This machine, made by Pawling & Harnischfeger, is equipped to cut trenches 12½ inches and 15 inches wide, any depth to 4½ feet. Power is furnished by a 20 h. p. 4-cylinder internal combustion motor, using gasoline, kerosene, or motor spirits as fuel. It has a sliding-gear quick-speed-change arrangement, to cut from 2.25 to 7.55 feet per minute, and a power grading device. We recommend the use of "corduroy grip" tractions.

The excavating wheel is of the open type, i. e., it has no axle and is so arranged as to obtain the maximum dept of trench with the minimum diameter of wheel. This member is constructed of wrought steel angles and plates forged to shape by machinery and true to form. Driving gears or cog racks, as they are sometimes called, are of cast steel, and are fastened to the wheel member. The buckets are of heavy plow steel plate forged to shape and sharpened at the cutting edge. They are pinned on and are easily removable.

Sewer Construction in Chicago, Ill., With a Ladder Type Excavator

By Stanley E. Bates, Assoc. Mem. W. S. E.

The annual amount of sewer construction in the city of Chicago, whose two and a half million inhabitants are spread out over an area of 202 square miles of flat prairie land, is very large. Last year 71.86 miles of sewers, ranging in size from 10-inch tile pipe to 9-foot brick sewers, were constructed under special assesment by the Board of Local Improvements at a cost of $1,371,813. This year the work will run about the same.

Contracts for building the smaller sewers generally are let in small sections of from one to five blocks. There is sharp competition among the contractors, and the work is always taken at a very low margin of profit. For this reason, some type of trench excavator is a practical necessity to any sewer contractor who bids for city work and wishes to make a fair profit on his contract.

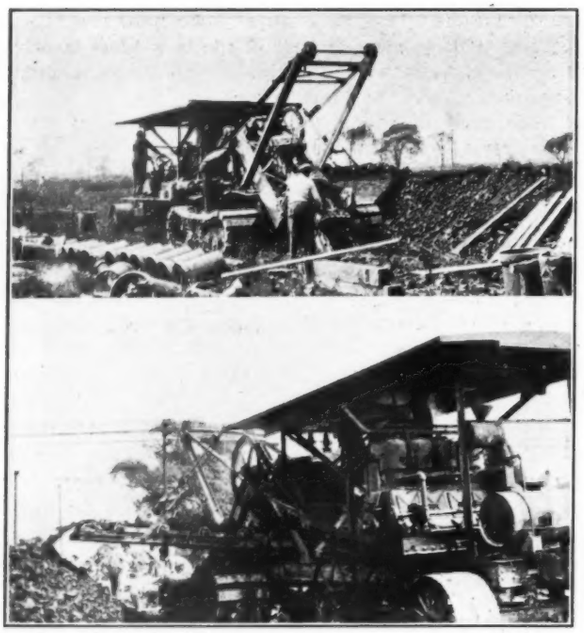
A good example of this type of work was found in the lay-

REPORT OF 102 KW DITCHER SHOP NO. 107 OWNED BY C.D. & J.T. PIERSON OF LEWIS & TERRE HAUTE IND.
GUMBO WHEEL & CASING.

NOTE! RECORD UNDER REMARKS, REASONS FOR ALL DELAYS, CHARACTOR OF SOIL, AND NATURE OF REPAIRS, IF ANY, START EACH DAYS "REMARKS" WITH THE DATE SO THAT THEY CAN BE CONNECTED WITH DATES GIVEN IN THE TABLE OF OPERATING DATA.

Date	Time: Time When Work Started	Time When Work Stopped	No. of Hours Worked	Delays: Noon	Stones	Break Downs	Miscel.	Total Hrs.	Delayed	Net Working Time	Costs: Fuel: Gal's Used Gas.	Kero.	Cost Per Gal. Gas.	Kero.	Cost of Lubricant	Total Cost	Labor: No. of Men	Salary	Per Day	Total	Incidentals: Item	Cost	Total Cost	Work Done: Size Trench Depth	Width	Length	Unit Costs: Total Cost Per Lineal Foot	Total Cost Per Cubic Yard
9-14-10	7 30	10 45	9 15							3 15	5		11¢		$0.15	0.73	3		2 00	2 11			2 84	3'-6"	11½"	787	0.0030	0.0232
15	7 30	6 00	10 30	-30			2-30	3-00	7 30	12	"		0.30	1.68	3	"	6 50			8 18	3'-6"	"	1650	0.0050	0.0378			
16	7 30	6 00	11 00	1-00			2-00	3-00	8 00	13	"		0.35	1.85	3	"	6 50			8 35	3'-6"	"	1952	0.0043	0.0345			
17	7 00	6 00	11 00	1-00			1-00	2-00	9 00	15	"		0.45	2.17	3	"	6 50			8 67	3'-6"	"	2887	0.0030	0.0241			
18	7 00	6 00	11 00	1-00			1-00	2-00	9 00	15	"		0.45	2.17	3	"	6 50			8 67	3'-8"	"	2310	0.0037	0.0289			
19	7 00	6 00	11 00	1-00			2-00	3-00	8 00	13	"		0.35	1.85	3	"	6 50			8 35	3'-6"	"	2838	0.0029	0.0237			
10-3-14	5 30	5 30	12 00	-30			1-30	2-00	10 00	20	"		0.60	2.90	4	"	8 00			10 90	3'-0"	"	5032	0.0021	0.0204			
Totals																													

REMARKS. MOST OF DELAYS REPORTED REPRESENT TIME REQUIRED TO MOVE FROM ONE DITCH TO ANOTHER FOR LAYING NEW LATERALS.



UPPER VIEW *illustrates tile placed in handy position along one side of trench. Lower illustration shows rear view of machine and belt conveyor discharge.*

ing of four blocks (one-half mile) of 12, 15 and 18-inch sewer on South Sangamon street, between 99th and 103rd streets, during August, 1915. The contractor was Garrett Barry, a capable organizer and experienced in small sized sewer building.

Mr. Barry's ditcher is that known as the "P. & H." ladder type excavator No. 153KC, manufactured by the Pawling & Harnishfeger Company, Milwaukee, Wis. This machine is designed to dig trenches up to a maximum depth of 15 feet and varying in width from 27 to 39 inches. The general details of construction and operation are shown in the illustrations.

The digging ladder is built up of structural steel shapes in a box section. It is pivoted at the upper end, the digging end being raised and lowered by a double, four-part, wire-rope hoisting tackle, the ropes leading to drums on the hoisting shaft near the rear end of the machine. The buckets are equipped with teeth and can be fitted with extensions on the sides for digging a wider trench. A cleaner set above the belt conveyor scrapes the buckets clean as they pass over the top of the ladder.

When new, the excavator was equipped with a 45-h.p., four-cylinder, vertical engine, burning either kerosene or gasoline. This was replaced a little later on with a 72-h.p. engine of the same general type and which has power enough to easily dig thru the stiffest blue clay to be found in the vicinity of Chicago. Under average working conditions the engine uses daily 40 gallons of gasoline, 2 gallons of oil and about 50 cents worth of hard grease and other oils, waste, etc.

On the Sangamon street job, the average depth of cut was 10 feet, and the width thruout 27 inches. This was of ample size to permit laying the largest size of pipe, 18-inch. The material excavated was a stiff blue clay, which the excavator dug into at a good rate of speed. According to the contractor, if there is sufficient power to the engine, the machine works better in very stiff clay than in a softer and more springy and sticky material.

Boulders, found in the clays of all the middle western gracial deposits, were occasionally encountered, but caused little difficulty. If of a large size, the machine had to be stopped until the stone was removed, but there were no breakages aside from an occasional tooth on the buckets.

The layout of the work and materials, while simple, showed good organization. The tile were placed in a line, all on one side of the street and as close to the trench as possible without being in the path of the excavator. The belt conveyor, which takes the excavated material from the buckets, was set so as to dispose of the dirt on the opposite side of the road from the tile. The operation of the belt conveyor can be seen in the photograph. It is 24 inches wide and of a length such that it will carry all of the excavated material a sufficient distance away from the ditch when digging maximum widths and depths. It can be adjusted to deliver on either side.

The engineer's grade stakes, the wheelbarrow and pails of cement, and all small tools and accessories were kept on the opposite side of the trench from the excavated material, which made possible an orderly and speedy progress of the work.

Ahead of the excavator two men were kept busy preparing the surface. Rubbish, such as wire, old bed springs, logs and other odds and ends likely to be found on unimproved and unused streets in the outlying districts of the city, were all removed and then the small inequalities in the ground were levelled up by planks for the wheels of the excavator to run on. The forward wheels are 34 inches in diameter and have plate steel tires 18 inches wide. Supporting the heavy ladder end are "Corduroy Grip" tractions, 30 inches wide and 7 feet between the center lines of the end sprocket shafts. The supporting blocks are made of hardwood, fitting on their upper surfaces into steel channels and shod on the bearing surface with steel plates. The pressure between the supporting blocks and the frame of the excavator is taken up by four pairs of chilled iron rollers.

Trench bracing and pipe laying followed close behind the excavator. The sheeting consisted of 2 by 10-inch planks about 9 feet long placed vertically against the sides of the trench at intervals of from 4 to 5 feet, sufficiently close to keep the stiff clay from caving in. Two adjustable braces were put between each set of planks, about 3 feet from the top and bottom of the trench, respectively.

Pipe laying was carried on less than 10 feet behind the bracing. The excavator can be adjusted to a very close mar-

METHOD OF LOWERING PIPE *as well as depth of trench.*

gin, which made it possible to lay the tile on the bottom of the trench with practically no digging or filling in with shovels to bring the pipe to grade. After cementing the joints, the pipe was immediately covered with about 2 feet of earth, shovelled in from the top, to protect the tile against breakage, in case a stone or heavy iron brace should accidentally fall into the trench. As soon as this was done, the braces and sheeting were removed and carried ahead to be used again. Under ordinary working conditions about a dozen braces, covering 50 to 60 feet of trench, were in place at one time.

Backfilling of the trench was sublet to another contractor at a price of 5c per lineal foot. This work was done by hand.

The construction of manholes, catch basins, and their connections, was included in the contract. This necessitated a good deal of hand excavation and the services of two bricklayers. Altogether there were 19 manholes and 19 catch basins.

When a manhole location was reached, the two ends of the tile adjacent to the manhole were laid on double rings of brick to preserve their grade and alignment. Shovellers then widened out the sides of the trench to a sufficient size to allow the standard 3-ft. diameter brick manhole to be built. The bracing, of course, had to be left in at this point until the manhole was built and all the connections were made.

The organization of the entire crew, exclusive of the contractor, who acted as foreman, was as follows:

Operator on excavator.

Two men ahead of the machine preparing surface.

One man in bottom of trench, bracing.

Three men on top, handing down braces and sheeting and attending to the top brace.

One pipe layer.

One man cementing pipe.

One man lowering pipe.

One man delivering pipe to man lowering same.

Two men filling in 2-ft. covering of earth.

Two men removing braces and carrying them ahead.

Average of four men engaged in miscellaneous jobs, such as preparing cement, pumping, delivering brick, etc.

Two bricklayers.

The operator received $8.00 per day and the bricklayers each $10.00 per day. Skilled laborers, of whom there were four on the job, received $4.60 per day and the remaining common laborers $3.20 per day. A day consisted of eight hours.

The entire job of 2,640 feet was completed in about nine working days, which included the construction of all manholes, catch basins and their connections and both end connections. This figures out an average of a little less than 300 feet per day. The best day's run of the excavator was 750 feet in seven hours or nearly 1 4-5 feet per minute.

Fred Courtney, mason inspector, represented the city of Chicago on the job.

Cost of Wood Block Paving in Findlay, O.

The city of Findlay, Ohio, is completing its wood block paving of Main street.

This job, which was awarded to the Brooks Construction Co., Ft. Wayne, Ind., consists of approximately 12,290 square yards north of the Main street bridge and 23,701 square yards south of bridge.

Bids were received on wood-block, brick and sheet asphalt, the contract being finally awarded in favor of three-inch Kreolite lug block outside of car tracks and to brick between the rails.

"The lug blocks we are using," states H. A. Glathart, city engineer, "are manufactured under the specifications of the Jennison-Wright Co., Toledo, Ohio. The lugs are an integral part of the block, extending its full depth in the direction of the grain. The lugs on the side of each block separate the courses, making a good strong grip for the hooks of horses and the chains of automobile wheels. At the same time the two side lugs are compressible, absorbing any possible transverse expansion or swelling and preventing the pavement from otherwise following the line of least resistance and buckling. The lug in the center of one end of each block is pointed, or wedge shaped, so that it acts as a uniform, collapsible spacer. This lug protrudes ¼ inch from the surface of the block. Pressure exerted by the swelling of the wood is concentrated on the points of the lugs, gradually crushing them as the force increases, allowing the pavement to expand as a whole, at will, within itself, without buckling. The end lug also tends to prevent transverse skidding and slipping. These blocks are treated with 12 pounds of oil per cubic foot of timber instead of with 18 pounds of oil per cubic foot as in ordinary rectangular block. Not only does this treatment effect a considerable saving but it is our opinion that this type of block with 6 pounds less treatment per cubic foot will give wear results equally as satisfactory as a heavier treated rectangular block, especially since the lug block are treated with the improved two stage process."

ITEMIZED BIDS.

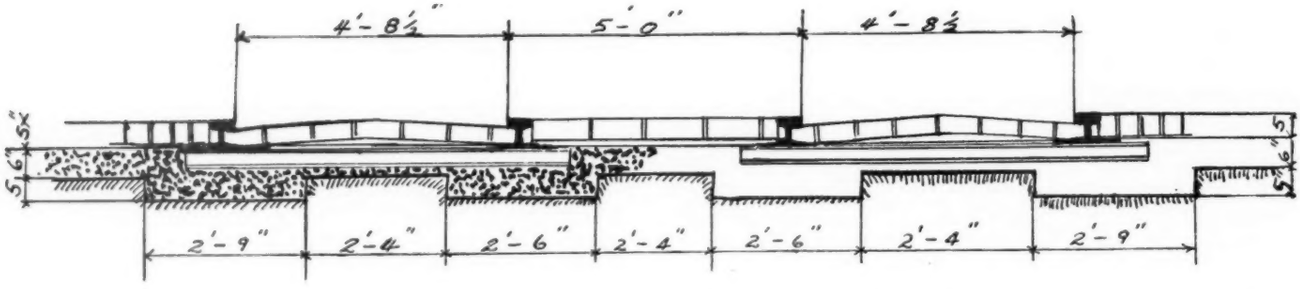
Following are itemized bids of the two lowest bidders, viz: Brooks Construction Co., of Ft. Wayne, and W. W. Hatch & Son, Indianapolis, Ind.:

NORTH OF BRIDGE ON MAIN STREET.

		Brooks Const. Co. Ft. Wayne, Ind.		W.W.Hatch & Son Indianapolis, Ind.	
		Price	Amount	Price	Amount
Old brick rem., sq. yds.	12,294	$0.10	$1,229.40	$0.06	$737.64
Excav., city, cu. yds.	2,465	.33	813.45	.35	862.75
Excav., R. R., cu. yds.	1,280	.37	473.60	.40	512.00
New sands. curb., ft.	2,000	.43	860.60	.38	760.00
Curb. redr., reset, ft.	1,040	.14	145.60	.14	145.60
Manhole	2	30.00	60.00	30.00	60.00
4-in. drain tile, ft.	3,100	.03	93.00	.05	155.00
New inlets	10	15.00	150.00	14.00	140.00
Old inlets	20	5.00	100.00	4.00	80.00
8-in. sewer, sp'ls. ft.	600	.45	270.00	.40	240.00
Limestone edg., ft.	400	.50	200.00	.40	160.00
M. H. tops, grade	10	5.00	50.00	3.00	30.00
Extra concrete, cu. yds.	200	3.50	700.00	4.50	800.00
Track drain cast'gs.	30	15.00	450.00	12.00	360.00
6-in. sewer complete	300	.45	135.00	.35	105.00
			$5,730.05		$5,147.99
Paving, city. sq. yds.	9.084	....	.....	....	.....
Paving, R. R., sq. yds.	340	....	.....	....	.....
Wood-block, 3-in. Kreolite		2.18	19,803.12	....	.....
Wood-block, 3-in. lug		2.16	19,621.44	2.24	20,348.16
Wood-block, 3-in. rectang		2.18	19,803.12	2.29	20,802.36
Brick, Met.		1.67	15,170.28		16,532.88
Brick, Wooster		1.69	15,351.96	1.82	16,532.88
Brick, Big Four		1.69	15,351.96	1.80	16,351.20
Brick, Hocking		1.68	15,261.12	1.79	16,260.36
Brick, Bolen		1.66	15,079.44	1.77	16,078.68
Brick		1.69	15,351.96	1.80	16,351.20
Brick		1.67	15,170.28		
R. R.					
Brick, Met.		1.67	15,170.28		
Brick, Wooster		1.74	5,585.40	1.87	6,002.70
Brick, Big Four		1.74	5,585.40	1.85	5,938.50
Brick, Hocking		1.73	5,553.30	1.84	5,906.40
Brick, Bolen		1.71	5,489.10	1.82	5,842.20
Brick		1.74	5,585.40	1.85	5,938.50
Brick		1.72	5,521.20		
Wood-block, 3-in. Kreolite.		2.21	7,094.10		
Wood-block, 3-in. lug		2.23	7,158.30	2.39	7,671.90
Wood-block, 3-in. rectang.		2.23	7,158.30	2.34	7,511.40
Wood-block			26,543.87		27,314.75

SOUTH OF BRIDGE ON MAIN STREET.

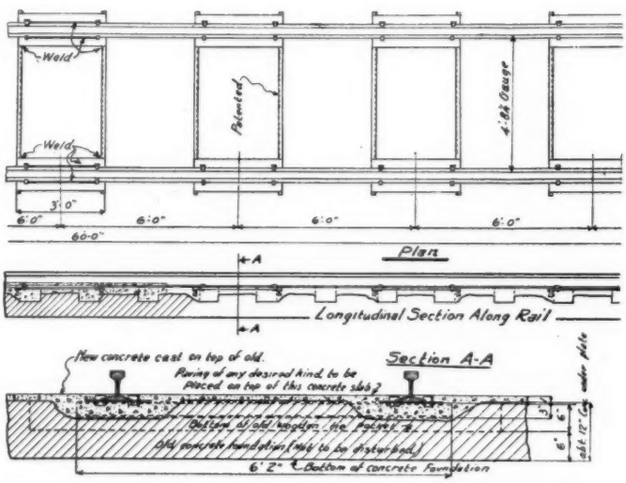
		Brooks Const. Co. Ft. Wayne, Ind.		W.W.Hatch & Son Indianapolis, Ind.	
		Price	Amount	Price	Amount
Old Brick rem., sq. yds.	23,701	$0.10	$2,370.10	$0.06	$1,422.06
Excav., city, cu. yds.	3,580	.33	1,181.40	.35	1,253.00
Excav., R. R., cu. yds.	1,789	.37	661.93	.40	713.60
New sandst. curb, ft.	4,000	.43	1,720.00	.41	1,640.00
Curb, red, reset, ft.	1,000	.14	140.00	.14	140.00
4-in. drain tile, ft.	6,000	.03	180.00	.05	300.00
New inlets	26	15.00	390.00	14.00	364.00
Old pipe rep	20	5.00	100.00	4.00	80.00
8-in. sewer, specials	600	.45	270.00	.40	180.00
Limestone edging	200	.50	100.00	.40	80.00
M. H. tops, grade	10	5.00	50.00	3.00	30.00
Extra concrete, cu. yds.	382	3.50	1,337.00	4.00	1,528.00



Track drain castings....	30	15.00	450.00	12.00	360.00
6-in. sewer complete....	600	45.00	270.00	45.00	270.00
			$9,220.43		$8,240.66
Paving, City, sq. yds....17,807					
Paving, R. R., sq. yds.... 5,834					
Wood-block, 3-in. rectang.		2.18	38,950.00	2.29	40,561.09
Wood-block, 3-in. Kreolite		2.16	38,592.72	2.34	41,808.78
Wood-block, lug		2.18	38,950.06		
Brick, Wooster		1.67	29,837.89		
Brick, Big Four		1.69	30,195.23	1.80	32,160.60
Brick, Dec. Duty					
Brick, Hocking		1.68	30,016.56	1.79	31,981.93
Brick, Bolen		1.66	29,659.22	1.77	31,624.59
Brick, Med.		1.69	30,195.23	1.80	32,160.60
Brick, Wooster		1.69	30,195.23	1.82	32,517.84
Brick, Nelson		1.67	29,837.89		
R. R.					
Brick, Met.		1.72	10,034.48		
Brick, Wooster		1.74	10,151.16	1.87	10,909.58
Brick, Big Four		1.74	10,151.16	1.85	10,792.90
Brick Hocking		1.73	10,092.82	1.84	10,734.56
Brick, Bolen		1.71	9,976.16	1.82	10,617.88
Brick, Med.		1.74	10,151.16	1.85	10,792.90
Brick, Nelson		1.72	10,034.48		
Wood-block, 3-in. Kreolite		2.21	12,843.14		
Wood-block, 3-in. lug ...		2.23	13,009.82	2.39	13,946.26
Wood-block, rect.....		2.23	13,009.82	2.34	13,651.50

Mr. Daniel Riedel, S. M. P., Toledo, Bowling Green & Southern Traction Company, in commenting on the use of steel ties on this job states: "This company is laying 100-pound T-rail on International steel ties in a concrete base. The street is being paved with brick between the rails and 18 inches outside of rails, and wood block to the curb. This company adopted the International steel tie for paved street work spaced 5 feet 6 inches centers for the following reasons: Maximum bearing surface for rail, perfect gage, and reasonable cost. The sketch at the top of the page shows cross section of this work which is now under construction."

The tie, above referred to by Mr. Riedel, is similar to the steel tie construction as used by the Cleveland Railway Company on the Brooklyn bridge, Cleveland, where they only had four inches of room under the rail. They use a 3-inch channel tie and their standard 7-inch T-rail. This tie consists of two 3-inch channels and two 13 by 36 inch plates, 5-16 inch thick and are fastened down with eight clips. This bridge is being built one-half at a time so that traffic can be carried on during construction. The old side of the bridge, which is on the left is being used while the new half is getting ready for traffic.



The above drawing illustrates a plan of rehabilitation in paved streets, which is done without removing the old concrete base, but just by taking out the old wooden ties, trimming off loose ends and placing in the steel twin ties.

TRACK *installed by the Cleveland Railway Company on Brooklyn Bridge, Cleveland, Ohio, using International steel ties.*

Motor Fire Apparatus as Philanthropist's Gift to Village

With the widespread knowledge of the benefits which come from adequate fire protection it is not often necessary, nowadays, for local fire companies to do long without equipment which will enable them to cope successfully with fire dangers which may arise in their community. Let it be noised about that the fire boys are going to make an effort to secure something better in the way of fire fighting equipment and some individual or group of citizens, prompted by public spirit of the worth-while sort, will invariably come to the rescue. It is not often, however, that an individual, of his own initiative, and without advance play for public plaudits, comes forth with the gift of a handsome, down-to-date and efficient motor fire apparatus as a free will offering in token of his appreciation of the good work the fire company in his home town has done in the past and as a stimulant for a continuance of their best efforts in the future.

To J. W. Packard, former head of the Packard Motor Car Co., Detroit, the village of Lakewood, N. Y., where Mr. Packard makes his summer home, is debted for a down-to-date motor chemical fire apparatus of the latest and most efficient type. On August 25th, during a fireman's field day

celebration to commemorate the laying of the corner-stone of a handsome new town hall and fire station, towards the erection of which Mr. Packard made liberal donations, the complete and practical Ford chemical truck and water hose trailer, shown in the accompanying illustration, was delivered to Lakewood Hose Company No. 1 as a complete surprise.

The apparatus, which is manufactured by The Hallock Engineering Company, Cleveland, Ohio, consists of a 35-gallon Holloway chemical tank of Lake Superior copper, with hand chemicals, 200 feet regulation chemical hose, 22-foot extension ladder, pike-pole, crowbar, fire-axe, gas searchlight, complete facilities for prompt recharge, etc., all mounted in a neat and compact way on a standard Ford model T chassis, fitted with oversize non-skid tires, extra heavy rear spring, electric lighting equipment, bumper and muffler cut-out. In addition a duplex gear trailer with capacity for 600 to 800 feet of standard water hose is provided. This trailer is so coupled that it can instantly be detached from the power car at the will of the driver by pressure on release pedal. Being of light and strong construction, having ball-bearing wheels and pneumatic tires, it possesses the ability to transport its full load almost without noticeable pull on the power car, and this combination of chemical truck with water hose trailer brings within reach of every town and village a modern, self-propelled fire apparatus at an exceedingly reasonable price.

Mr. Packard, who witnessed a demonstration of Lakewood's chemical truck upon delivery has expressed himself as being highly pleased with the promptness, efficiency and ease of operation of the apparatus.

Pneumatic Drills and Rammers

The "Crown" pneumatic sand rammer, as illustrated by Fig. 1, derives its name from the fact that it is equipped with the Ingersoll-Rand "Crown" valve, which valve is made of hardened steel, working under unbalanced air pressure in a hardened steel valve box clamped between the cylinder and the head block of the tool.

This type of rammer is not only largely used in concrete work, but for such special purposes as tamping concrete and earth around water mains. The following figures show the results of observations under ordinary conditions:

RAMMING EARTH *around water mains for Board of Water Supply, New York City.*

LITTLE DAVID DRILL *reaming rivet holes in New York aqueduct pipe line.*

Size of Cope	Time in Ramming By Hand	Time in Ramming By Sand Rammer	Ratio of Reduction	Per Cent Time Saved
12′x18″x 4″	5 min.	1 min.	1:5	80
12′x18″x10″	10 min.	1½ min.	1:6.6	85
6′x 3″x 6″	20 min.	3 min.	1:6.6	85
6′x 6″x 8″	35 min.	8 min.	1:4.4	77
8′x 6″x 6″	1 hr.	10 min.	1:6	83
7′x 3′ x12″	1 hr., 30 min.	16 min.	1:5.6	82
15′x30″x16″	2 hrs.	27 min.	1:4.4	77
12′x 7′ x16″	2 hrs., 12 min.	34 min.	1:3.9	74
87″x159″x10″	4 hrs.	40 min.	1:6	83
19″x90″x15″	8 hrs.	1 hr., 30 min.	1:5.3	81

It is to be especially noted that these figures include not only the final ramming, but the more careful peining as well; and the total time covers the completed job. These results, showing a ratio of advantage of machine over hand ramming varying from 1:3.9 to 1:6.6, and a time saving of 74 to 85 per cent may be considered fairly representative of the reduction in time and labor cost to be effected.

Mietz Oil Engine Receives High Award at Panama-Pacific Exposition

We are informed that the Superior Jury of Awards of the Panama-Pacific International Exposition, upon revising the award of Gold Medal recently made to the August Mietz Machine Works, has raised said award from Gold Medal to Medal of Honor, in the Department of Machinery, under the classification "Injection Oil Engines."

The exhibit is located in the Machinery Building, and includes eight examples of this company's design and construction, of horizontal and vertical oil engines, for stationary and marine service, being one each of 3h. p. horizontal; 18-h. p. horizontal in operation; 50-h. p. horizontal, single cylinder; 75-h. p. vertical 3-cylinder, in operation direct-connected to generator; 9 by 10-inch vertical air compressor set; 22-h. p. marine 5-cylinder; 60-h. p. marine 3-cylinder, and 200-h. p. 4-cylinder, in operation by compressed air.

The 75-h. p. vertical 3-cylinder unit is carrying the load for the transformer exhibit of the Thordarsen Electric Manufacturing Company, of Chicago. This load is normally 20 to 20 kw. and affords an excellent opportunity for showing the Mietz & Weiss engine under load. This engine, recently overhauled afetr several months of service at the exposition, showed a surprisingly small amount of carbon deposit in the combustion spaces. It has been operating every day on fuel of 24° to 28° gravity, with perfect success.

Altho the internal combustion engines have not heretofore been used in large size to any great extent in this country, the field for their use is rapidly widening, and they are finding favor in a great variety of industries on account of the low fuel cost, entire absence of "standby" losses, and other operating advantages, which result in marked economy as compared with even the most efficient steam units.

One field in which several installations of the Mietz & Weiss oil engines have recently been made, is in the light ships along the Atlantic coast. All of these vessels are equipped with power for furnishing the compressed air required in fog signalling. Several others, particularly those located in the most exposed stations, are also equipped with propelling machinery, this having been found necessary in putting the ship on station and returning her to her repair base; also to relieve the strain on the mooring chain during heavy weather.

Until within a few years steam has most generally been used for all power purposes aboard these light vessels. Within the past two years, however, few or no light vessels have been equipped with steam power, nor have steam installations been made in any of the old vessels.

Five ships, namely, Nos. 54, 96, 98, 101 and 102 have been or soon will be equipped with the Mietz & Weiss oil engines for propulsion purposes. These ships also carry Mietz & Weiss engines for compressing air for various purposes about the ship, such as operating the siren, starting the main engines, and driving winches, windlasses, fire and bilge pumps.

Light ship No. 54 developed a speed of 8.1 knots per hour on her trial trip, with the engine running at only 200 r. p. m. instead of its normal speed of 240 r. p. m. On the run of 103 miles the elapsed time of light ship No. 54 was 12 hr. 45 min. with a fuel consumption of approximately 9.2 pints per h. p. hour. The report of the inspector in charge of the test shows that the control and reversing of the engine, and maneuvering of the ship was satisfactory under all conditions. The reasons for changing from steam to oil engine power are mostly from the standpoint of economy. With the steam installation it is necessary to maintain full boiler pressure at all times in order successfully to meet emergency conditions, whereas with oil power, the engine can be turning over and delivering its full output on five minutes' notice.

Of the United States light vessels mentioned above, Nos. 54, 98, 101 and 102 are equipped with Mietz & Weiss direct-reversible oil engines of 100, 150 and 200 h. p. These engines are of the two-stroke cycle type, in which every down stroke of the piston is a power stroke. The fuel is sprayed directly into the combustion chamber, shortly before completion of the compression stroke. In marked contrast to the ordinary two-stroke cycle internal combustion engine using gasoline as fuel, there is no loss of fuel thru crank case leakage or thru the exhaust ports. A very efficient and sensitive governor regulates the amount of oil injected at each stroke in direct proportion to the load on the engine.

In case of breakage of propeller shaft or loss of propeller, engine speed will not rise appreciably above normal. For ordinary maneuvering purposes, engine is controlled by a throttle lever on the governor. Starting and reversing are effected by means of the S & W distributing valve, which is standard equipment on all of the larger Mietz & Weiss marine oil engines of three or more cylinders. The use of this valve greatly facilitates maneuvering. Throwing the lever to one side starts the engine; returning it to the center stops the engine, and throwing it to the other side reverses the engine. The one lever positively controls the fuel injections to all cylinders, while the speed of the engine is controlled by the throttle on the governor. Since by use of this distributing valve the direction of rotation of the engine shaft itself is reversed, the customary clutch and reversing gears are unneccessary, and the engine and propeller shafts are coupled rigidly together.

Mietz & Weiss direct-reversible marine oil engines are built in 3, 4 and 6-cylinder types, ranging from 45 h. p. to 600 h. p., and are manufactured by the August Mietz Machine Works, 128 Mott street, New York City.

Knox Four-Wheel Tractor for Fire Apparatus

The Knox Motors Company, of Springfield, Mass., one of the pioneers in the field of motor-driven apparatus, have recently perfected and placed on the market a new four-wheel tractor for fire service. Simplicity, accessibility, and reliability have been the keynote of the design thruout, and the Knox Company make even greater claims for this model than any they have heretofore perfected. Its success in the commercial world is already assured, and its value for fire department service is already recognized.

While the principle of attaching the tractor to steamers, ladder trucks, aerials, etc., is the same as on the three-wheel tractor, the design of the tractor proper has been changed materially. Many new and exclusive features have been incorporated in this new model, which have heretofore not been attempted in motor vehicle construction. Among these might be mentioned the patented hydraulic brakes, enabling the operator to exert with ease tremendous power on the rear axle drum; the differential lock with which the tractor and its load may be operated in bad going and on slippery places; control board at the steering column, within easy reach of switches, fuses, gages, and speedometer; unique jack shaft brakes; the ease of adjustment and renewal of shoes.

The motor, while retaining the overhead feature, is of entirely new design and exhibits some clever ideas. It has four cylinders, 5-inch bore and 5½-inch stroke, and is capable of pulling its load over the steepest grades and as fast as safety will permit on level road.

The fifth wheel, or trailer platform, is made of unusual size, and is so constructed as to fit the platform of any steamer, ladder truck, or other form of apparatus. Moreover, in coupling, there is no weakening of the trailer apparatus, no riveting, and no substitution of heavy springs. The connection is made by means of an ordinary king bolt,

Woodside Avenue, Narberth, Penna.
Treated with "Tarvia B" in 1914.

Narberth's Experience with Tarvia—

Here is one of the pretty, residential streets of Narberth, Penna., showing a stretch of macadam which was treated in 1915 with "Tarvia B" to make it dustless, durable and automobile-proof.

"Tarvia B" is a coal tar preparation which is applied, inexpensively, without heating. It reinforces the top surface of the macadam and adds greatly to the life of the roadway—so much so that its use is a real economy.

Mr. Edward C. Stockes, Chairman of the Highway Committee of Narberth, writes: "The 50,000 yards of macadam, treated with Tarvia by you, has proven very satisfactory. We have found it a big saving in keeping roads in perfect condition and settling the dust. The best recommendation I can give is to compare the roads not treated with those already finished . . . which will speak for themselves."

That order of 50,000 yards, executed in 1915, came as the result of a test which Narberth made with Tarvia the previous year. We predict that Narberth will become another of those "Tarvia towns" which make the use of Tarvia a steady practice year after year.

Illustrated booklets on request. Address our nearest office.

Special Service Department

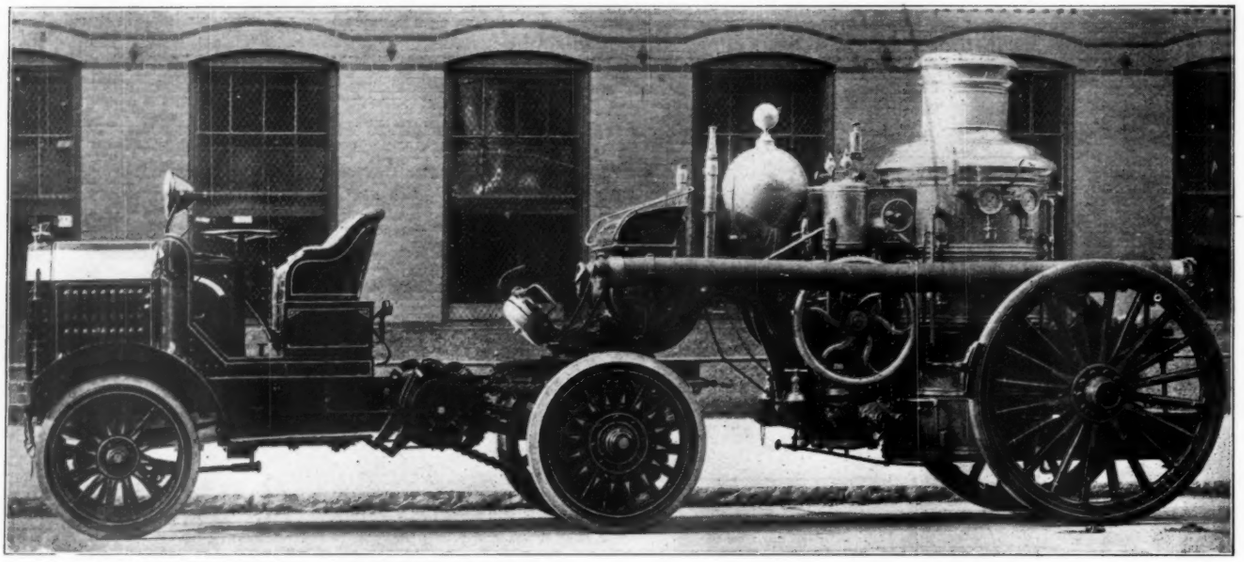
This company has a corps of trained engineers and chemists who have given years of study to modern road problems.
The advice of these men may be had for the asking by anyone interested.

If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

BARRETT MANUFACTURING COMPANY

New York Chicago Philadelphia Boston St. Louis Cleveland Cincinnati Pittsburgh
Detroit Birmingham Kansas City Minneapolis Salt Lake City Seattle Peoria

THE PATERSON MFG. CO., Limited: Montreal Toronto Winnipeg Vancouver
St. John, N. B. Halifax, N. S. Sydney, N. S.



KNOX FOUR-WHEEL TRACTOR *hauling steam fire engine.*

and the original springs are preserved. Both these points are of vital importance, and are not found where the rear platform is made a permanent and integal part of the fire apparatus itself.

The advantages of Knox detachability need only to be mentioned to be appreciated. In case of accident to the motor mechanism, or during the periodical over-hauling necessary on all motors, the fire apparatus itself can be quickly detached by removing the king pin. Or, at the discretion of the fire chief, any Knox tractor can be quickly transferred to some other fire station. And in towns where there is one steamer, the original front axle can be preserved, and in case of an unexpected emergency, the change back to horse-drawn methods can be made in thirty minutes. In short, the Knox fire tractor is a gasoline horse, handled with even greater ease than fire horses; ready to be shifted immediately on occasion; capable of driving as fast as safety permits, and with a degree of braking control hitherto unobtained on high-speed motor vehicles.

Full equipment is furnished with this new model, including the well-known Bijur electric starting and lighting system; trailer platform complete; two electric side lamps; one electric tail lamp; one electric search light; Willard storage battery, 6 volts, 160 ampheres; electric siren horn; Pyrene fire extinguishers; speedometer; complete set of skid chains, etc.

Several options are given on the tire equipment, standard sizes of which are 34x5, single, front; 40x6, dual, rear.

Trade Notes

An interesting chart is to be found in one of the circulars about electrical prosperity week, which is November 29 to December 4, 1915. It shows the rapid decrease in the cost of electric lighting, especially since the introduction of the Mazda lamp.

At the Labor Day parade held in St. Louis, on September 6, 1915, first and second prizes were put up for the best constructed trucks. One hundred and twenty-five trucks of all styles and carrying capacities competed in this parade, and B. A. Gramm's trucks, manufactured by the Gramm-Bernstein Co., of Lima, Ohio, won first and second prizes. This line of trucks is represented in St. Louis by the Best Service Truck Company.

In former days, all the celite taken from the Kieselguhr quarries at Lompoc, Cal., was hauled to the drying yards by mule teams, and eventually the finished product, silocel, as well. Motor trucks were not used because the digging away of the mountain itself makes permanent roads impractical. A 2½-ton Kissel Kar truck was put into service, however, and has proved itself capable of taking every grade and every condition of loose roadbed without pause, moving far more rapidly than mule teams and carrying many times as much.

Trade Publications

The Buckeye Engine Co., Salem, O., will send circulars and information about their trial offer for their improved Buckeye electric blue printing machine which is in use by over 1,200 firms.

The complete line of best products in steel lath, studs, corner protections and various kinds of reinforcement for concrete and plaster work in buildings of the Trussed Concrete Steel Co., Youngstown, O., is shown in their latest circular.

The Hotchkiss Lock Metal Form Co., Binghamton, N. Y., have issued a new booklet describing a job in which their forms were used, which is well worth reading.

John W. Moore, 607 Merchants Bank building, Indianapolis, Ind., has issued a circular letter concerning his system of air-lift pumping for city and town water supplies from wells.

The Snow & Petrelli Mfg. Co., New Haven, Conn., issue a circular descriptive of the Universal matchless sewage spraying nozzle.

A contractors' service bureau has been opened at 50 State street, Albany, N. Y., maintained by Charles F. Murphy, Jr., Inc., of New York, and McGuire & Co., Inc., of Syracuse, N. Y., to furnish information and service regarding public work done by the state of New York and the details of contractors' information on their business relations with the state departments, without charge to those having contracts with the state.

The Rigid Tool Holder Co., Baltimore, Md., send a booklet descriptive of the device from which they derive their name.

The National Tube Co., distribute generally some literature concerning their products which was prepared for the San Francisco exposition. An index of National bulletins is also received.

The Brownhoist Shnable patent drag-line bucket is the subject of a special booklet of The Brown Hoisting Machinery Co., Cleveland, O., showing all the steps of its operation in various materials.